

# Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

DECEMBER 1978/\$1

**AM Stereo — Soon On The Air?**  
**Security Systems to Protect Property**  
**Electronic Gifts to Buy and Build**

**Build a Computer-vs-You Chess Game**

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**1978**  
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display-allowance  
plan is within  
last three pages.

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**In This**  
**Issue**

**Lafayette LR-120Db AM/Stereo FM Receiver**  
**Dual C 819 Cassette Deck**  
**Crown DL2 Digilogic Control Center**





# FOR THOSE OF YOU WHO ARE HAVING SECOND THOUGHTS ABOUT YOUR FIRST CB.

Move up to the all-new Cobra 29GTL. It's the third generation of the trucker-proven Cobra 29. And like the 29 and the 29XLR before it, it advances the state of the art.

Transmitter circuitry has been refined and updated to improve performance.

Receiver circuits have been redesigned to include dual FET mixers, a monolithic crystal filter and a ceramic filter to reduce interference and improve reception.

By improving the transmitter circuitry the 29GTL keeps you punching through loud and clear. By incorporating new features for better reception everything you copy comes back loud and clear.

So if you're having second thoughts about your first CB, make your next CB the Cobra 29GTL.

We back it with a guaranteed warranty and a nationwide network of Authorized Service Centers where factory-trained technicians are available to help you with installation, service and advice.

But more important than that, we sell it at a price you won't have second thoughts about.



**Punches through loud and clear.**

Cobra Communications Products  
**DYNASCAN CORPORATION**  
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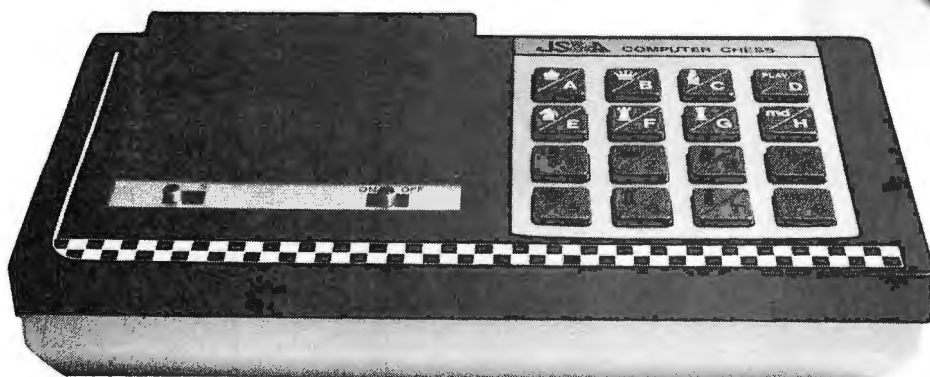
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*The JS&A Mini Travel Alarm will fit in your briefcase, pocket or purse and is no larger than four quarters.*



*The new JS&A Chess Computer plays six levels of chess and costs only \$99.95.*

# The Winners

*These two products continue to be our best sellers. Can you figure out why?*

The two products shown above are our best selling new products. The Chess Computer compares with similar computers selling for up to \$400. The JS&A Mini Travel Alarm compares to the \$100 Seiko alarm but is smaller and less than half the price.

Is there more to these products than value? Let's take a closer look. The following are descriptions of these two new items with our conclusions at the end.

## THE MINI TRAVEL ALARM

It's small. And because it's small, it fits anywhere. In your briefcase or in your pocket.

The new JS&A Mini Travel Alarm measures only 3/8" x 1 1/4" x 2 1/2" and has a small easel support on the back. Just set the alarm, and the electronic beep will wake you up. The clock movement is totally solid-state, and a built-in night light lets you view the time in the dark.

But the JS&A Mini Travel Alarm does more. First, it makes a great pocket watch. The small imitation black leatherette carrying case that comes with the unit has a window so you can view the time even when the unit is in its case. Secondly, it tells accurate time—within fifteen seconds accuracy per month. And finally, it's inexpensive—only **\$29.95** complete with carrying case and two readily-available hearing aid batteries. It makes a perfect gift for everyone on your gift list.

There is also a deluxe version with a built-in timer and dual time zone capability. You can now display one time while keeping the second time in memory.

The Mini Travel Alarm can be ordered by

calling our toll-free number below or sending your check for **\$29.95** for the regular version or **\$39.95** for the deluxe version. Please add \$2.50 postage and handling and Illinois residents add 5% sales tax.

## THE JS&A CHESS COMPUTER

It's a chess-playing robot. The new JS&A Chess Computer is not only programmed with the rules of international chess, but it has a brain that thinks for itself.

You enter your move and the computer examines all the probabilities and makes its move. There are six levels of play—from beginner to professional—so the game increases in difficulty as you become more proficient. And you can change levels right in the middle of a game if the robot starts to beat you.

The computer is small, easy to store, and is played with your own board and chess pieces. The JS&A Chess Computer has been programmed to handle all the international chess rules including castling, *en passant*, and pawn promotion. The entire unit is housed in a handsome case only 4" x 7" x 2 1/2" high, weighs 14 ounces and comes with an AC adapter.

One of the major breakthroughs has been its price. The JS&A Chess Computer is available for only **\$99.95** complete with AC adapter and complete instructions. (Add \$2.50 for postage and handling and Illinois residents please add 5% sales tax.) If you play chess, you already own half of the system—your board and chess pieces. With JS&A's Chess Computer, you'll own the other half plus a very clever opponent.

## OUR CONCLUSIONS

Why are the above two products so successful? Value would seem the most obvious reason. These products easily represent 50% lower prices than popular brand name products. Or is it features? Each product has real advantages over the competition. Or is it simply our 30 day trial period? It's the most consumer-oriented way to use and experience a product before you buy.

Why do people buy these products from JS&A? Value? Certainly. Features? Yes. But most importantly, we give you the assurance that if you are not satisfied with any JS&A product, you may return it within 30 days for a prompt and courteous refund. There's no stuffy sales clerk to ask you embarrassing questions, no parking problems, and no long lines. And we'll even refund our \$2.50 postage and handling charge.

Why not join the space-age revolution with one or both of our most exciting new products. Order any one of our two winners at no obligation, today.

**JS&A** NATIONAL SALES GROUP

Dept. PE One JS&A Plaza  
Northbrook, Ill. 60062 (312) 564-7000  
Call TOLL-FREE ..... 800 323-6400  
In Illinois Call ..... (312) 564-7000

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## Bearcat® 250 Features:

- **50 Channels/5 banks**—Program 50 frequencies from infinite frequency combinations. Designate certain banks for specific types of activity, for example, use bank 1-10 for Police, 11-20 for Secret Service, 21-30 for Drug Enforcement Agencies, etc.
- **5-Band Coverage**—Includes Low and High VHF bands, UHF and 2 meter plus ¼ meter amateur bands. With special programming techniques, this unit can monitor additional frequencies not published in factory specifications.
- **Self-Destruct**—In case your scanner falls into enemy hands, you can electronically erase up to 64 frequencies in storage memory with only two key strokes.
- **Search/Store**—"Hands-off" automatic search operation that locates and "remembers" active frequencies.
- **Search/Recall**—Used in conjunction with search, displays frequencies found in search/store sequence.
- **Communications Electronics**—quality control approval rating #1. Our highest quality grade for technologically sophisticated equipment.
- **CrystalLess**—Without ever buying a crystal, you can select from all local frequencies by simply pushing a few buttons.
- **Priority**—Samples programmed priority frequency on channel 1 every 2 seconds regardless of other scanner operations—important for professionals who must monitor a certain frequency.
- **Time**—Brilliant digital LED clock—will display hours, minutes and seconds. Extremely accurate!
- **Count**—Frequency "traffic analysis" may be easily recorded to keep track of potentially hostile forces. Automatically counts numbers of transmissions on each channel to determine the most active frequencies.
- **Non-Volatile Memory**—No batteries required to retain memory, even when scanner is unplugged. MNOS integrated circuit utilized for memory.
- **Scrambler/Tape Audio Output**—Top secret cryptographic messages may be received and decoded by connecting the Bearcat 250's audio output jack to a correctly keyworded decrypting device, even if it utilizes the National Bureau of Standards, Data Encryption Standard.
- **Small Size**—The Bearcat 250's small physical size lends itself to government monitoring applications. When used with a battery power supply and a tape recorder, the Bearcat 250 may be easily concealed in an attaché case for unattended, unobtrusive surveillance.
- **Auxiliary**—On/Off control of auxiliary equipment (tape deck, alarm, light, motor) when transmissions occur on programmed channels. Now, law enforcement agents can activate a tape recorder by remote control when a "body mike" transmission is received.
- **Speed**—Choice of either 15 or 5 channels per second scan speed for closer monitoring of desired frequencies.
- **Limit**—Sets the upper and lower frequencies of the user controlled search range.
- **Birdie-Lockout**—Avoid annoying scanner "lockup" during search mode. Scanner will skip over any programmed birdies.
- **Search Direction**—Determines in which direction search goes for faster return to desired frequencies.
- **Direct Channel Access**—Move directly to desired channel without stepping through all channels.
- **Automatic Squelch**—Factory-set squelch automatically blocks out unwanted noise.
- **Decimal Display**—Shows frequency and channel number as well as programmed function.
- **Deluxe Keyboard**—Makes frequency and feature selection easy for simple programming.
- **Patented Track Tuning**—Receive frequencies across the full band without adjustment. Circuitry is automatically aligned to each frequency monitored.
- **Selective Scan Delay**—Adds a two-second delay to prevent missing transmissions when "calls" and "answers" are on the same frequency.
- **Extended Frequency Coverage**—With special programming techniques, the Bearcat 250 can monitor 125-146 MHz, and 399-420 MHz in addition to the normal frequencies, without special modifications.
- **Simple Programming**—Simply punch in on the keyboard the frequency you wish to monitor.
- **Space Age Circuitry**—Custom integrated circuits... a Bearcat tradition in scanning radios.
- **Rolling Zeros**—This Bearcat exclusive tells you which channels your scanner is monitoring.
- **UL Listed/FCC Certified**—In addition to the #1 rating from Communications Electronics, the UL and FCC certification assures you of quality design and manufacture.

The new Communications Electronics Bearcat® 250 is an incredible scanning radio offering the scanning professional and the knowledgeable scanning enthusiast more monitoring capabilities, more frequency versatility, than any other scanning monitor available today.

It uses patented Bearcat integrated circuitry, so there's never a crystal to buy. With pushbutton ease, up to 50 channels can be programmed in five banks of ten channels each. The keyboard is easy to comprehend, simple to use. All functions are instantly displayed in bright LED numbers and letters.

All programmed frequencies and pertinent scan instructions are memorized in an electronic memory that operates even when the unit is unplugged from wall power—there is no need for batteries.

Not only will the Bearcat 250 capture more scanning action, it will "remember" where and how often it heard that action. Now it's easy to identify which frequency is used most often. It will search automatically through a selected frequency range and memorize in its search memory up to 64 active frequencies. To determine what frequencies were found during the search store mode, simply push the recall button and they will be displayed one at a time. Press the enter key and any of these frequencies is entered automatically into the scan memory.



## Bearcat® 250 Specifications

- Frequency Reception Range**
- |          |             |
|----------|-------------|
| Low Band | 32-50 MHz   |
| VHF Band | 146-174 MHz |
| UHF Band | 420-512 MHz |
- Extended frequency range**  
With special programming techniques the Bearcat 250 will also cover the following frequencies with a reduction in sensitivity.
- |          |             |
|----------|-------------|
| VHF Band | 125-146 MHz |
| UHF Band | 399-420 MHz |
- Scanner Dimensions**  
27.0 cm Wide x 7.6 cm High x 19.4 cm Deep  
(10 3/4" Wide x 3" High x 7 3/4" Deep)
- Scanner Weight**  
2.27 Kilograms  
(5 pounds)
- Shipping Weight**  
3.18 Kilograms  
(7 pounds)
- Power Requirements**  
(Note: 220 Volt AC Export model may be available April, 1979)  
110-130 V ac, 60 Hz, 15 Watts  
12-15 V dc, 8 Watts
- Audio Output**  
At least 2.0 Watts rms
- Antenna**  
Telescoping (supplied)
- Scan Rate**  
15 or 5 channels per second
- Sensitivity**  
0.4 microvolts for 12dB SINAD on VHF bands, UHF band slightly less
- Selectivity**  
Better than:  
-60dB @ ±25 KHz
- Audio Quality**  
The BC-250's audio is more noise-free and suffers less distortion than the Bearcat 210 by a margin of 10 dB or more.
- Image Rejection**  
The Bearcat 250 rejects image frequencies by at least 8 dB better in all bands than the Bearcat 210.
- Connectors**  
External antenna and speaker; AC & DC Power; Auxiliary control output; tape audio output
- Accessories**  
Vehicle mounting bracket and hardware, AC & DC power cords

The Communications Electronics® Bearcat 250 even has an automatic count function that remembers how often any or all programmed frequencies were activated by transmissions while scanning. This will help you determine the value of your frequency selections. The Bearcat 250 will literally search and seize active frequencies.

An important feature for professionals who must monitor a specific frequency is the priority channel, Channel 1. If desired, whatever frequency is programmed for this channel will be sampled every two seconds anytime the set is turned on.

## THE INCREDIBLE, NEW BEARCAT® 250 SCANNER.

LEADING THE WAY TO REAL EXCITEMENT

The Bearcat 250 has an auxiliary output feature which can be programmed to actuate external devices such as a light, alarm, motor, etc.

### ONE-YEAR LIMITED WARRANTY

With your Bearcat 250, we will send all accessories, a complete set of simple operating instructions and a one-year limited warranty. If service is ever required, just send your receiver to one of our approved national service centers. When you purchase your scanner from Communications Electronics, you're buying from the world's leader in no-crystal scanners. We've sold more synthesized scanners than any other company.

### NO OBLIGATION 31 DAY TRIAL

Test our Bearcat 250 for 31 days before you decide to keep it. If you do, you'll own the most sophisticated and technologically advanced scanner in the world. If for any reason you are not completely satisfied, return it in new condition with all accessories in 31 days, for a courteous and prompt refund (less shipping charges).

### ADVANCED YET UNCOMPLICATED

Besides all the advanced features that put the Communications Electronics® Bearcat 250 light years ahead of any other scanning radio, it has the superior engineering and "standard" features that have made Bearcat the greatest selling scanner in America. Bearcat's patented track tuning insures full band coverage for maximum reception. And a single electronically switched antenna eliminates the need for an additional low band antenna. A detailed service manual is also available for \$15.00 postpaid.

### BUY WITH CONFIDENCE

The Communications Electronics® Bearcat 250 is an extraordinary scanning instrument. It provides virtually any scanning function that the most professional monitor could require. The Bearcat 250 lets those who need to know, know more. To get the fastest delivery of your super synthesized Bearcat 250, send or phone your order directly to our Bearcat Scanner Distribution Center. Mail orders to: Communications Electronics, Box 1002 - Department PE12, Ann Arbor, Michigan 48106 U.S.A. Send \$319.00 plus \$5.00 for U.P.S. shipping or \$9.00 for U.P.S. air shipping (Michigan residents please add 4% sales tax). Foreign orders invited at a slightly higher cost. International customers, please send special shipping information (in our catalog) before ordering. Further price discounts are available to quantity buyers. Suggested list price is \$399.95 but you can get 6 Bearcat 250's @ \$309.00, 12 units @ \$299.00, 24 units @ \$289.00, 48 units @ \$279.00, 96 units @ \$269.00, 252 units and up @ \$259.00. Add \$15.00 for each 6 scanners ordered for U.P.S. ground shipping. Add \$195.00 shipping charge for each 6 scanners, on international shipments, or write for a pro-forma invoice. If you have a Master Charge or Visa card you may call and order toll free 800-521-4414 to place a credit card order. If you are outside the U.S. or in Michigan dial 313-994-4444. All order lines at Communications Electronics® are staffed 24 hours.

Since this Bearcat scanner is the most popular unit ordered through our Scanner Distribution Center, you must order your Bearcat 250 today at no obligation, to assure prompt delivery.

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Box 1002, Ann Arbor, Michigan 48106 U.S.A.



**ORDER YOUR BEARCAT 250 TODAY!**

FOR YOUR FREE COMMUNICATIONS ELECTRONICS BEARCAT® SCANNER CATALOG, CIRCLE 1 ON FREE INFORMATION CARD



## Coming Next Month

● A GUIDE TO PROJECTION TV RECEIVERS

● BUILD A UNIVERSAL ELECTRONIC TIMER

● FREQUENCY CONTROL METHODS FOR FM TUNERS/RECEIVERS

**NOTE:** PART 3 of THE MINI-WAVE, SCHEDULED FOR DECEMBER, WILL BE PUBLISHED IN JANUARY. WATCH FOR IT THEN!

Cover Art by George Kelvin

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## FCC STOMPS ON R-F MODULATORS

I felt it was just a matter of time before the FCC turned its attention to the widespread use of r-f modulators for equipment other than video games. It finally did, advising that it plans to notify makers of r-f modulators that sales of the devices are illegal!

The FCC is pointedly talking about adding separate r-f modulators to personal computers, though the principle could well be carried over to security systems. Most personal computers are not supplied with r-f modulators and TV antenna isolation switches, as are TV video games. A modulator and computer combined, however, are considered to be class I TV devices; separately, they do not fall into this classification. Together, then, they must be approved by the FCC.

One does not require an r-f modulator to obtain video, of course. Simply use a video monitor or connect the computer directly to the video amplifier circuit of a conventional TV receiver. The former route is costlier, but you'll get the sharpest pictures. This is especially important when viewing the small characters generated by some computer systems. Home-brewing a video input jack on a TV receiver requires circuit modification. It's less expensive than buying a monitor, could be dangerous if modifying a "hot" chassis, and falls short in resolution as compared to a video monitor since its video bandpass is, at best, 4.2 MHz. Both approaches provide better video quality than using a vhf oscillator at the antenna terminals of a TV receiver.

But using an r-f modulator has its advantages: no muss, no fuss. The obvious objection is that the modulator and/or isolation switch could cause interference to other equipment, such as your neighbors' TV reception.

There are a host of problems that arise as a result of the FCC's starting a drive for such Class I devices to be approved by the agency. Firstly, how does one compel present end users of r-f modulators/personal computers to submit the package to the FCC for type acceptance—especially when the four-figure evaluation charge is sometimes more than the end user paid for his entire system.

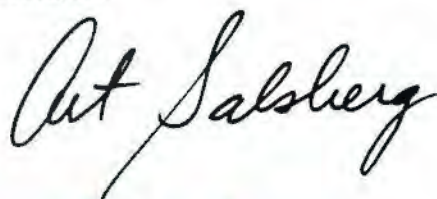
If the personal computer maker were to incorporate an r-f modulator into its equipment, the same up-front monies would have to be paid. Many of the smaller manufacturers would find this to be prohibitively high. Moreover, governmental delays in finalizing type acceptance (a not uncommon occurrence, judging from video game and CB transceiver experiences with the FCC) or notification of failure might be the kiss of death to a new, promising model; maybe even to the company itself.

Interestingly, there is no prohibition on the sale of r-f modulators in kit form, according to an FCC spokesman. So though it is illegal to sell these devices separate from the video source in assembled form, one can still sell a kit version with impunity.

What continues to distress me and others is the lack of foresight on the part of the FCC. The agency has ignored this problem and similar ones for what seems interminable periods of time when it could have acted with dispatch as soon as it became evident that Class I FCC rules, among others, were being violated.

Just imagine the penalties that would be extracted if private industry operated in this manner. Ignore illegal use of one's trademark, for example, and it can be lost forever. That's why Xerox's legal staff jumps on anyone using the name generically, such as in the incorrect expression, "I'm going to Xerox this page."

I'm surprised, too, that television receiver manufacturers haven't grasped an opportunity to meet growing needs of consumers by incorporating video input jacks and audio output jacks into their better models. I suggested this to a TV manufacturer some three years ago. If the company had followed this counsel, it would have made life easier for computer and audio enthusiasts (hi-fi audio is now available on network and public broadcast channels) as well as the FCC. It would have given the manufacturer a leg up on competition, too.



**Best Wishes for a Joyous Holiday Season  
and a Happy New Year**



# The Age of Affordable Personal Computing Has Finally Arrived.

Ohio Scientific has made a major breakthrough in small computer technology which dramatically reduces the cost of personal computers. By use of custom LSI micro circuits, we have managed to put a complete ultra high performance computer and all necessary interfaces, including the keyboard and power supply, on a single printed circuit board. This new computer actually has more features and higher performance than some home or personal computers that are selling today for up to \$2000. It is more powerful than computer systems which cost over \$20,000 in the early 1970's.

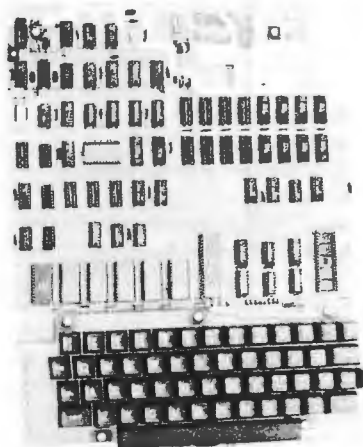
This new machine can entertain your whole family with spectacular video games and cartoons, made possible by its ultra high resolution graphics and super fast BASIC. It can help you with your personal finances and budget planning, made possible by its decimal arithmetic ability and cassette data storage capabilities. It can assist you in school or industry as an ultra powerful scientific calculator, made possible by its advanced scientific

math functions and built-in "immediate" mode which allows complex problem solving without programming! This computer can actually entertain your children while it educates them in topics ranging from naming the Presidents of the United States to tutoring trigonometry all possible by its fast extended BASIC, graphics and data storage ability.

The machine can be economically expanded to assist in your business, remotely control your home, communicate with other computers and perform many other tasks via the broadest line of expansion accessories in the microcomputer industry.

This machine is super easy to use because it communicates naturally in BASIC, an English-like programming language. So you can easily instruct it or program it to do whatever you want, *but you don't have to*. You don't because it comes with a complete software library on cassette including programs for each application stated above. Ohio Scientific also offers you hundreds of inexpensive programs on ready-to-run cassettes. Program it yourself or just enjoy it; the choice is yours.

Ohio Scientific offers you this remarkable new computer two ways.



## Challenger 1P \$349

Fully packaged with power supply. Just plug in a video monitor or TV through an RF converter to be up and running.

## Superboard II \$279

For electronic buffs. Fully assembled and tested. Requires +5V. at 3 Amps and a video monitor or TV with RF converter to be up and running.



## Standard Features

- Uses the ultra powerful 6502 microprocessor
- 8K Microsoft BASIC-in-ROM  
Full feature BASIC runs faster than currently available personal computers and all 8080-based business computers.
- 4K static RAM on board expandable to 8K
- Full 53-key keyboard with upper/lower case and user programmability
- Kansas City standard audio cassette interface for high reliability
- Full machine code monitor and I/O utilities in ROM
- Direct access video display has 1K of dedicated memory (besides 4K user memory), features upper case, lower case, graphics and gaming characters for an effective screen resolution of up to 256 by 256 points. Normal TV's with overscan display about 24 rows of 24 characters; without overscan up to 30 X 30 characters.

## Extras

- Available expander board features 24K static RAM (additional), dual mini-floppy interface, port adapter for printer and modem and an OSI 48 line expansion interface.
- Assembler/editor and extended machine code monitor available.

## ORDER FORM

Order direct or from your local Ohio Scientific dealer.

☐ I'm interested. Send me information on your:

☐ Personal Computers ☐ Business Systems

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Interested in a bigger system? Ohio Scientific offers 15 other models of microcomputer systems ranging from single board units to 74 million byte hard disk systems.

DECEMBER 1978

CIRCLE NO 39 ON FREE INFORMATION CARD

# OHIO SCIENTIFIC

America's Largest Full Line Microcomputer Company  
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I had been trying to eliminate a loud, high-pitched alternator whine coming through my

## UPGRADE KEYPAD DESIGN

"The Versatile Keypad" (August 1978) was a fine article on keypads. I have a suggestion to add, however. One should consider using a 74C922 IC in the design. This chip decodes the switch matrix without diodes and features internal scanning and debouncing. It can also

## SMOKE DETECTOR SOURCES

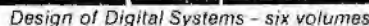
In the September 1978 "Solid State" column, you mentioned only Motorola and National as suppliers of ICs for smoke detectors. The largest two IC manufacturers are in fact Siliconix and Supertex. Also, you mentioned ionization chamber detectors but did not mention where the chambers themselves can be purchased. The Amersham Corp. is the largest supplier of radioactive products in the world and the leading supplier of both radiation sources and ionization chambers for smoke detectors.—G. W. Dunbar, Jr., Amersham Corp., Arlington Heights, IL.

The article "Now You Can Enjoy Hi-Fi Television Sound" (September 1978) presents some misconceptions regarding the development of diplexing for television audio. Work on the new diplexing system, which went into service on January 13, 1978 (prior to the Super Bowl), began at the recommendation of a joint TV industry/Bell System committee. Bell Laboratories provided the overall system engineering and Western Electric awarded the contract for the diplexer to Farinon.

Bell System and independent telephone companies installed the diplexers at TV stations. Pools of portable diplexers have been established under the management of the A. T. & T. Long Lines Dept. to be used in the provision of part-time (occasional) service to network and non-network customers. The new method does indeed deliver high-fidelity FM sound and has resulted in substantial cost saving to A. T. & T. Present plans call for offering the second audio channel in the near future, leaving open the option of stereophonic sound for TV.—*H. J. Cohan, A. T. & T.*

After building the "Compressor Guard" (June 1978), I encountered a problem. The red LED can draw enough current to prevent the relay from dropping out. The LEDs would change, but the relay would remain energized. I solved the problem by installing an 8.2-volt zener diode (1N756 or similar) in series with LED1. The cathode end of the zener diode goes to the LED2/D3 relay junction, while the anode end goes to the anode terminal of LED1.—James P. Donovan, Louisville, KY

The address of the supplier in the U. S. A., of the TBA231 dual op amp (IC1 in my article "Listen to a New World of Sounds with Ultrasonic Detector," July 1978) has been changed to SG-ATES Semiconductor Corp., 79 Massasoit St., Waltham, MA 02154; Tel: 617-891-3710. Note also that the Fairchild  $\mu$ A739 can be used. —*Brian Dance*



The products of digital electronics technology will play an important role in your future. Calculators, digital watches and TV games are already commonplace. Now, microprocessors are generating a whole new range of products. Personal computers will be in widespread use very soon. Your TV, telephone and computer will combine to change your children's education, your job—your entire way of life.

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These courses were written by experts in electronics and learning systems so that you could teach yourself the theory and application of digital logic. Learning by self-instruction has the advantages of being faster and more thorough than classroom learning. You work at your own pace and respond by answering questions on each new piece of information before proceeding.

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DESIGN OF DIGITAL SYSTEMS**

Design of Digital Systems is written for the engineer and serious hobbyist who wants to learn more about digital electronics. Its six large-format volumes—each 11½" x 8½"—are packed with information, diagrams and questions designed to lead you step by step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of microprocessors and computers.

## CONTENTS

The contents of Design of Digital Systems include:

Book I: Octal, hexadecimal and binary number systems; representation of negative numbers; complementary systems; binary multiplication and division.

**Book 2:** OR and AND functions; logic gates; NOT, exclusive-OR, NAND, NOR and exclusive - NOR functions; multiple input gates; truth tables; DeMorgan's Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.

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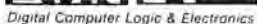
**Book 3:** Half adders and full adders; subtractors, serial and parallel adders, processors and arithmetic logic units (ALUs); multiplication and division systems.

Book 4: Flip-flops; shift registers; asynchronous counters; ring, Johnson and exclusive-OR feedback counter; random access memories (RAMs); read-only memories (ROMs).

**Book 5:** Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets, instruction decoding; control program structure.

**Book 6:** Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming assemblers; executive programs, operating systems, and time-sharing.

## BASIC COURSE



## CONTENTS

Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though you should have an aptitude for logical thought. It consists of 4 volumes—each 11½" x 8½"—and serves as an introduction to the subject of digital electronics.

Contents include: Binary, octal and decimal number systems; conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; DeMorgan's Laws; design of logical circuits using NOR gates; R-S and J-K flip-flops; binary counters, shift registers and half-adders.

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Recording studios are designed for perfect sound reproduction. Your living room wasn't.

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At Pioneer, we've developed a simple, and inexpensive way to avoid redecorating with an audio consultant: the Pioneer SG9500 graphic equalizer.

In brief, the SG9500 plugs into the back of your receiver or amplifier and acts as a massive

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So you can cut the exact frequencies that are rattling the windows.

Or boost the bass your bookcases are soaking up.

Or simply remix the music to compensate for your own musical tastes, or bad speaker placement.

Of course, if you're not lucky enough to be blessed with components that are all of Pioneer quality, you can also use the SG9500 to overcome deficiencies in the rest of your audio equipment. Like tape hiss in your cassette deck. Or audible rumble in your turntable.

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## New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

### SAE Preamp/Amps

SAE's Model 2922 amplifier (a combination of the Model 2900 preamp and the Model 2200 power amp) is rated to deliver 100 watts/channel into 8 ohms at no more



than 0.05% THD and features a parametric equalizer for creating virtually any sonic effect. The preamp and amplifier are actually separate sections including a power supply. The only parts in common are the chassis and the power switch. Other features include tape/line equalization for tape recording flexibility, tape/line filters to protect tape recordings, a two-stage phono circuit that is said to eliminate TIM characteristics, and separate bass, treble and midrange controls for each channel. Address: Scientific Audio Electronics, Inc., 701 E. Macy St., Los Angeles, CA 90012.

CIRCLE NO. 92 ON READER SERVICE CARD

### Multicore Solder Sampler Kit

A kit of five types of solder, each for a particular application, is available from Multicore Solders. Packaged in feed-out metal dispenser packs, the kit includes solders for stainless steel and jewelry, plumbing,



sheet metal and general metal joining, electrical wiring, electronic assemblies and pc boards, and aluminum. The kit is intended to give the user a good idea of the purposes for which the various alloys and flux combinations were formulated. Included with each Sampler Kit is a "Solder User's Guide." \$8.95. Address: Multicore Solders, Westbury, NY 11590.

CIRCLE NO. 93 ON READER SERVICE CARD

### One-Hand Keyboard

A one-handed keyboard for computers, terminals, displays, and other 128-character ASCII- or ISO-coded devices is available from NewO in both right- and left-hand models. It features snap-action



switches, key-pressed signals, and strobe pulses to signal that data is available. The small keyboard is for touch typing and data entry where a free hand is needed. The Writehand™ keyboard can be interfaced with any computer, terminal, printer, or other device that accepts 7-bit code signals and provides the nominal power required. Keys are mounted on a 5" (12.7-cm) diameter hemisphere that conveniently accommodates the human hand. The shape and key locations have been designed so that the fingers and thumb naturally fall on the appropriate switches. There are four models: right-hand, left-hand, large (thumb to little-finger span 8½" or more), and small. Power required is 5 volts at 52 mA dc. Address: NewO Company, 246 Walter Hays Dr., Palo Alto, CA 94303.

CIRCLE NO. 94 ON READER SERVICE CARD

### Pioneer AM/FM Stereo Receiver

The Model SX-880 AM/FM stereo receiver from Pioneer is rated at 60 watts/channel into 8 ohms, over 20 to 20,000 Hz at no more than 0.05% total harmonic distortion.



The power amplifier section features a direct-coupled OCL output and two discrete power transistors in each channel. A dual-gate MOSFET in the FM front end is said to provide a sensitivity of 10.3 dBf (1.8 microvolts) mono. Two meters provide signal-strength and center tuning indications, while two other meters indicate output power from 0.01 to 120 watts, without sensitivity switching. Other claimed ratings for the amplifier: phono frequency response, 20 to 20,000 Hz  $\pm 0.2$  dB; IM distortion (50:7060 Hz = 4:1, from AUX), less than 0.03% for 30 W/channel at 8 ohms; and phono input sensitivity, 2.5 mV/50,000 ohms. The FM tuner section has a 50-dB quieting sensitivity rating of 16.2 dBf (3.6 microvolts); capture ration of 1.0 dB; and alternate channel selectivity of 75 dB. Dimensions are 18.875"W x 5.5"H x 12.625"D (48 x 14 x 32 cm). \$425. Address: U.S. Pioneer Electronics Corp., 85 Oxford Dr., Moonachie, NJ 07074.

CIRCLE NO. 95 ON READER SERVICE CARD

### Portable Dual-Trace Oscilloscope

Ancrona Corp. has announced availability of its new Model TTM 303 dual-trace, triggered-sweep portable oscilloscope with three power modes. The scope has a 15-MHz vertical bandwidth and can be oper-



ated from the ac line (90 to 260 volts at 48 to 440 Hz), internal NiCd battery, or external dc (11 to 30 volts) source. It features a 3" (7.7-cm) CRT, 5x magnifier, X-Y operation, and compact size. Overall size is less than 11¼" x 8¾" x 4" (29.8 x 22.2 x 10.2 cm) and weight is 10 lb (4.5 kg). \$895. Address: Ancrona Corp., P.O. Box 2208, Culver City, CA 90230.

CIRCLE NO. 96 ON READER SERVICE CARD

### PAL Firesticks CB Antennas

The latest models of the PAL Firestick top- (Continued on page 10)



# Measure resistance to $.01\Omega$ at a price that has no resistance at all.



*B&K-PRECISION  
DMM Model 2810  
\$130<sup>00</sup>*

The new B&K-PRECISION Model 2810 may well be the highest resolution  $3\frac{1}{2}$ -digit DMM available. It is certainly the lowest cost DMM to provide  $.01\Omega$  resolution. With ohms resolution ten times greater than most DMM's, the 2810 allows you to detect shorted windings in coils, transformers or motors.

You'll also be able to accurately check the low contact resistance of switches, relays, breaker points or connectors. Many poor solder connections or PC board imperfections can also be located.

The 2810 is a full-feature DMM providing selectable high-/low-power ohms, auto-zeroing and 100% overrange reading. Twenty-nine ranges provide maximum readings to 1500 volts DC, 2

amps, and 20 megohms. All ranges are fully overload protected. Typical DC accuracy is 0.5% with resolution to  $100\mu V$ . And unlike many electronic voltmeters, the 2810 is RFI shielded and can be accurately used in high R-F energy fields.

B&K-PRECISION also has a full complement of optional accessories for the 2810. Accessories include a carrying case, wire tilt stand, AC adapter/charger, high-voltage probe, direct/isolation probe, NiCad batteries and 10-amp current shunt.

At \$130.00, the 2810 is a standout value in today's DMM jungle. Don't resist the temptation...contact your local distributor for immediate delivery.

**B&K PRECISION** **DYNASCAN CORPORATION**

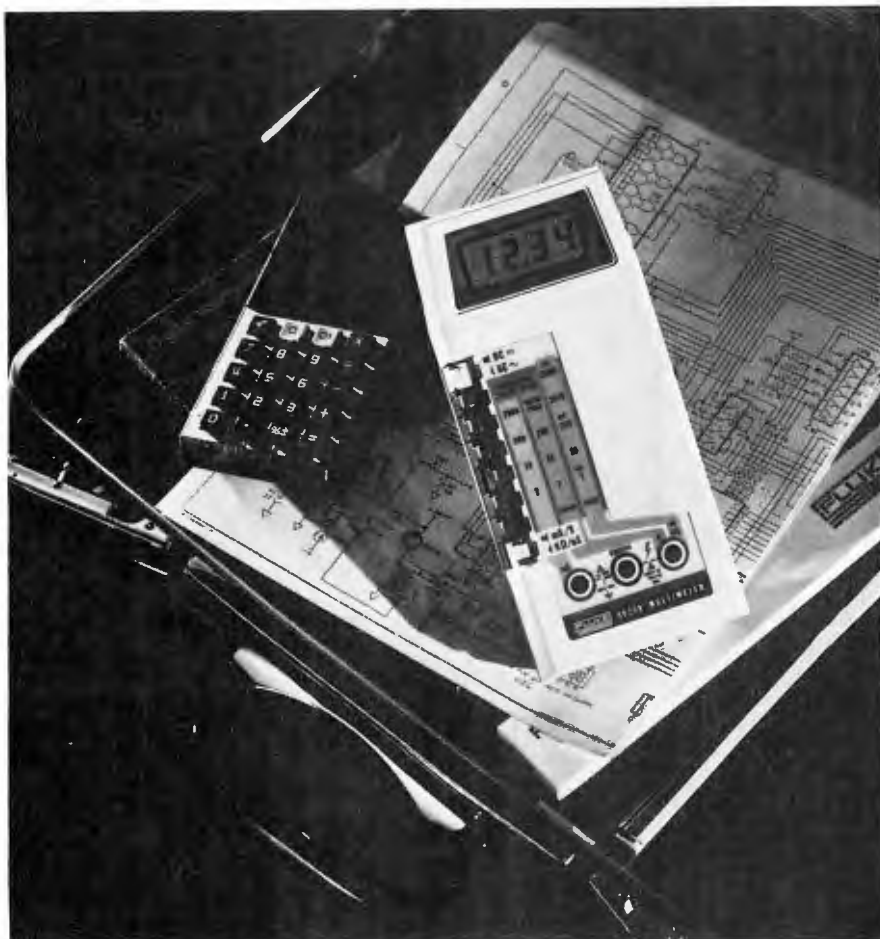
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tee it'll live up to published specs for a full year.

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## The DMM for Home Electronics Experts.



.2507-7304

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loaded fiberglass antennas are available in four lengths, three color schemes, and three basic mounts. The antennas are rated by the manufacturer for frequencies from 26.900 to over 27.700 MHz with no tuning necessary, and an average SWR of 1.5:1. According to the company, a noise-limiting cover reduces static up to 50%. The antennas themselves are available in lengths of 3, 4, 5 and 7 feet, at prices of \$14, \$15, \$16 and \$18, respectively. Colors available are red with white tip, or red tip with black or white shaft. The mounting kit options, which range from \$13.50 to \$18 for single mounts and \$25 to \$32 for twin mounts, include a no-hole trunk-lip mount and single or twin mirror mounts with terminal lug or coax connector base terminations. Address: PAL Firestick Antenna Corp., 2614 E. Adams, Phoenix, AZ 85034.

CIRCLE NO. 97 ON READER SERVICE CARD

### Wrist Static Strap

This new wrist grounding strap to eliminate static discharges that could damage MOS devices is 48" long, with a built-in, encapsulated 270,000 ohm or 1 megohm resistor. The wrist contact section is an adjustable bead chain, with a swivel to prevent tangling and twisting. Address: Controlled Static Co., 9846 Jersey Ave., Santa Fe Springs, CA 90670

### Akai Open-Reel Tape Deck

The GX-267D open-reel tape deck from Akai has an ac-servo, direct-drive capstan motor and two reel motors. Tape speed is 3¾ or 7½ ips and the deck can be oper-



ated either vertically or horizontally. Function controls are solenoid operated for record/playback in both directions. Other features include the use of GX glass and crystal ferrite heads; dual VU meters; 4-digit tape counter; pause and timer-set rec-  
(Continued on page 12)



# Spend less. Test more.

Faster, easier and more economical digital testing. That's what CSC's Logic Probes are all about. And that's what engineers, technicians and hobbyists need, to deal with the increased use and complexity of digital circuits.

Unlike oscilloscopes, meters and other conventional test equipment, CSC probes are *logic-state oriented*. Just touch the probe to a circuit node and *instantly* read logic state, detect level transitions, check duty cycles. And store high-speed, low-rep-rate events that even fast scopes miss.

By accurately detecting the state of individual logic elements without removing ICs or cutting copper paths, CSC's circuit-powered,



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LP-1 has a minimum detectable pulse width of 50 nanoseconds and maximum input frequency of 10 MHz. This 100 K ohm probe is an inexpensive workhorse for any shop, lab or field service tool kit. It detects high-speed pulse trains or one-shot events and stores pulse or level transitions, replacing separate level detectors, pulse detectors, pulse stretchers and pulse memory devices. All, for less than the price of a DVM.

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LP-2 performs the same basic functions as the LP-1, but for slower-speed circuits and

without pulse memory capability. Handling a minimum pulse width of 300 nanoseconds, this 300 K ohm probe is the economical way to test



circuits up to 1.5 MHz. It detects pulse trains or single-shot events in TTL, DTL, HTL and CMOS circuits, replacing separate pulse detectors, pulse stretchers and node state analyzers.

## **LP-3 LOGIC PROBE. \$69.95\***

Our LP-3 has all the features of the LP-1 plus extra high speed. It captures pulses as narrow as 10 nanoseconds, and monitors pulse trains to over 50 MHz. Giving you the essential capabilities of a high-quality memory scope at *about 1/100th the cost*. LP-3 captures one-shot or low-rep-rate events all-but-impossible to detect any other way. All without the weight, bulk, inconvenience and power consumption of conventional methods.



Use CSC's highly versatile logic probes for testing, debugging or servicing any type of digital circuit. They give you a lot of information about IC circuit conditions... and help you do more in less time. For less money.

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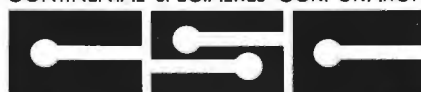
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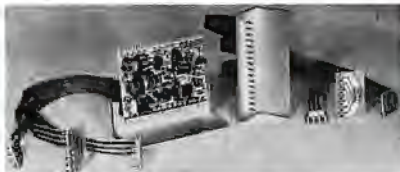
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Shire Hill Industrial Estate, Units 1 and 2  
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TLX 817477

ord mute controls; and single-direction, auto, or continuous auto-reverse play. Wow and flutter are claimed to be less than 0.06% rms at 7½ ips, with S/N better than 56 dB, distortion less than 0.5% and frequency response 30 to 25,000 Hz  $\pm 3$  dB at 7½ ips. Dimensions are: 18.5"H x 17.3"W x 9.8"D (47 x 44 x 25 cm). Weight is 45.5 lb (21 kg). Approximate price is \$800. Address: Akai America, Ltd., 2139 E. Del Amo Blvd., Box 6010, Compton, CA 90224.

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## Sylvania Cables For TV Repairs

Sylvania's "Chek-A-Board" extension cable kits enable technicians to service solid-



state TV receiver modules without removing the chassis. Designed for use with RCA and Zenith modular TV receivers, the

kits contain cables with female connectors for modules on one end and mating chassis connectors on the other end. Using the cables, an operating module can be brought out onto the workbench for testing and repairs. The extension cables feature plated-alloy conductors on heavy-gauge fiberglass printed circuit boards and consist of stranded multilead ribbon cable. Each side of the cable is color-coded differently to assure proper orientation. The cables are 24" (61 cm) long. Address: General Telephone & Electronics Corp., Public Affairs Dept., 1 Stamford Forum, Stamford, CT 06904.

## Osawa Tonearm

The Osawa Model AC-300MKII tonearm features a single needle-point support, adjustable oil-damping system, and interchangeable plug-in arm stems to optimize performance for a wide variety of phono cartridges. The arm support system is designed to eliminate resonance effects associated with conventional gimbal, knife-edge, and ball-bearing mountings. A knob atop the arm permits the user to adjust the oil damping system to flatten out the



low-frequency resonant peak created by the stylus/tonerarm combination. Elimination of the headshell concentrates the arm's mass at the base of the arm to reduce effective mass. It also permits interchanging the standard straight arm stem with a selection of S-shaped, other straight-line, and straight carbon graphite arm stems. An adjustable antiskating control, oil-damped cueing lever, and locking rest-stop are provided. \$325 for tonearm, \$60 arm stem. Address: Osawa & Co., 521 Fifth Ave., N.Y., NY

CIRCLE NO. 99 ON READER SERVICE CARD

## EICO 3-Digit Digital Multimeter

The EICO Model 272 portable digital multimeter has a claimed accuracy of 0.5% on dc volts and 1.0% on all other functions. It measures to 1000 volts dc, 600 volts ac, 1000 mA (1 A) dc and ac, and 1 megohm resistance. Its 0.3" (7.6-mm) LED numeric display flashes when an overrange condition exists and automatically displays polarity on dc. Input impedance is 10 megohms. The DMM is powered by four AA cells (supplied), and a testpoint for checking battery condition is built in. Dimensions are 6"L x 3.75"W x 3.75"D (15.2 x 9.5 x 4.4 cm). \$69.95. Address: EICO Electronic Instrument Co., Inc., 108 New South Rd., Hicksville, NY 11801.

CIRCLE NO. 100 ON READER SERVICE CARD

## Suburban Personal Security Alarm

The "Protektor" is the name of a solid-state, battery-powered personal security and safety alarm from Suburban Electronics Co. It is totally self-contained, can be used on doors, medicine cabinets, in vehicles, in the office, and even on luggage, camera bags, handbags, and briefcases. The Protektor can be armed simply by setting a "secret" code on two combination wheels. Then the slightest movement will trigger it to emit a piercing alarm sound. \$29.95. Address: Suburban Electronics Co., 1250 W. Dorothy Ln., Dayton, OH 45409.

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## The priceless gift of learning now has a price: \$599. And a name: the Radio Shack TRS-80™ Microcomputer. And now, at last, your child has a chance to discover Tomorrow on Christmas morning.

"Tomorrow" is an electronic world, based on computers — and it's already here. In it your child can be a number in a machine, like a robot. Because he or she does not understand either the number or the machine. Or your child can be pleasurably elevated into this brave new world with a gift that has only become affordable in recent months.

### Quotes from Fascinated Customers

The Radio Shack personal computer surely ought to be on the gift list of every concerned parent, despite that \$599 — though less than a moped — is costlier than an electric train. A father writes to tell us "this investment is one of the most significant in value to our family and to the future education of our child that we have ever seen."

A Californian, aged 12, writes to tell us that he's "too young to go to work for Radio Shack . . . but maybe we could work a deal where I could write some programs for you." An educator thanks us for "making possible the tapping of human innovation and creativity on an unprecedented scale."

### Advice for Parents Who Care

In your lifetime the possibility of owning or giving a computer — up to now — was unthinkable. A computer? That can teach? Remember? Display on its own screen? Play games? Complete with a standard typewriter keyboard? Unthinkable — up to now.

But now the Tomorrow Machine is not only thinkable but practical, affordable and available at every Radio Shack store and participating dealer. The TRS-80 personal computer system? For the kids? For Christmas? Crazy? Like a fox!

**Radio Shack**  
The biggest name in little computers™

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Fort Worth, Texas 76102



Plain-English 232-page manual makes it easy to start programming with no computer experience.



Includes 12" video screen, 53-key keyboard, compact cassette recorder and 2 game cassettes.



TRS-80 is expandable and can grow in power and utility. Everyone in the family becomes involved, entertained, informed.



# Stereo Scene

By Ralph Hodges

## SO YOU WANT TO BUILD... A SPEAKER!?

**F**ROM ALL indications, there are some audio enthusiasts who like to build speakers, though they are in the minority. Let's assume that you are one. What's your motive? Is it: (1) A plan to utilize that expensive table cutting saw you incautiously bought last year? (2) A wish to get more creatively involved with your high-fidelity interest? (3) A desire to assemble a real killer that will make the neighbors wish you had never been born? (4) Part of an interior decorating scheme. (5) An economy measure? (6) An irresistible compulsion to challenge the "state of the art"?

None of the above is really a bad idea; even (6) has its possibilities (rank amateurs have come up with some astonishingly good speaker systems), although they are remote. And it is certainly true that anything you create yourself that actually works is likely to give more satisfaction than a store-bought item. (My last speaker-system design, which provided several years of genuine listening pleasure, was finally sold to a composer living somewhere in the north woods. He immediately altered the crossover network and disconnected the mid-range driver—a move that, much as I loved that loudspeaker, I have to admit was an excellent idea.) But when it comes to sheer practicalities, there are certainly some factors to give one pause.

Take economy, for example. If you start from scratch, you face the problem of acquiring raw drivers and crossover-network components at the quantity-discount prices a mass producer can command—if he doesn't actually make his own drivers and crossovers. And what about enclosures? You will pay rather more than he does for veneered particle board, but it is true that you can beat him

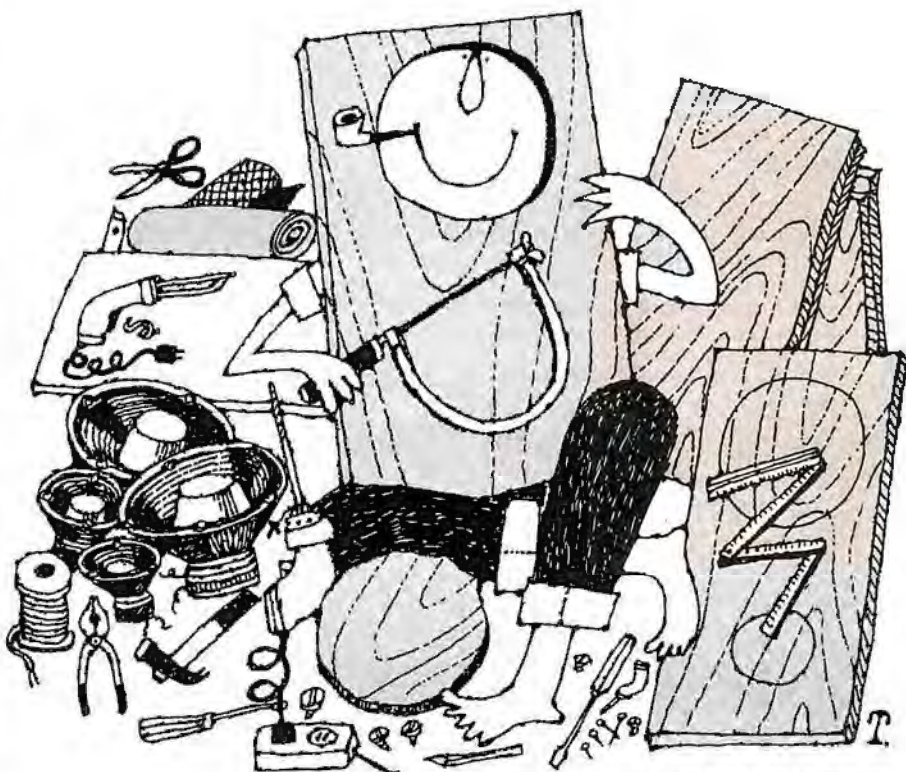
out if you construct your cabinets out of concrete (a time-honored and effective technique) or some other material next to impossible for him to ship. In the end, however, he has probably got you.

Then again, you can avoid starting from scratch. Loudspeaker kits are sold by Altec, Audionics, Electro-Voice, Heath, I. M. Fried, JBL, Speakerlab, and no doubt a host of others. A kit is either a set of raw drivers, a crossover network, and comprehensive instructions for building an enclosure, or all of the aforementioned plus a knocked-down enclosure that you put together and finish yourself. Of course, in either case, you

abandon the creative role of designer and become instead a loudspeaker assembler. But on the positive side, you cannot go wrong. The instructions you are given—at least in the case of the suppliers listed previously—will infallibly result in a pre-proven design with distinguished performance credentials.

**Going Wrong.** Carrying things beyond the kit stage takes us into the land of unpredictables. For example, say you have found some unused space around the house—a dispensable closet or simply the empty area behind the walls—that seems appropriate for a built-in speaker system. Proceeding methodically, you calculate the volume of this space, alter it if necessary, and go about selecting a woofer designed to work into such a volume. (Probably you would be thinking in terms of an air-suspension design, but a ported configuration is also a possibility.) You duly consult the woofer's manufacturer about the type and amount of damping material the space should contain (in most cases you can expect excellent cooperation from the woofer's manufacturer as far as such advice goes; some of the larger manufacturers even keep a staff on hand to answer customer questions), and you throw the whole thing together in a weekend, having chosen a midrange and/or tweeter and the necessary crossover compo-

(Continued on page 20)



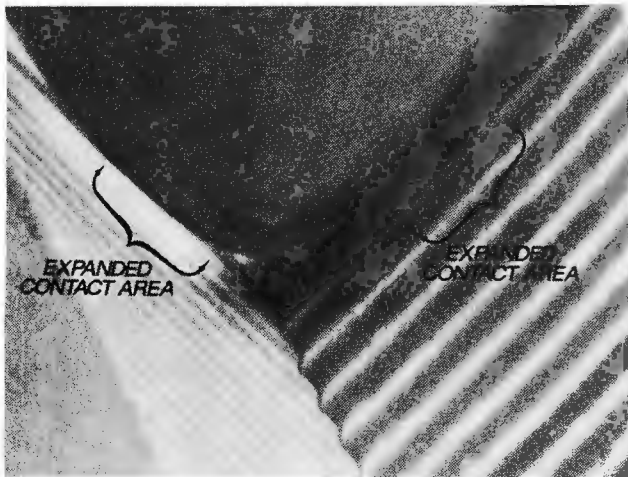


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*Kitty Puckett checks out 45 rpm stamper, while auditioning one at 33 $\frac{1}{3}$  rpm.*



*Scanning Electron Beam Microscope photo of Stereo-hedron® stylus, 2000 times magnification; brackets point out wider contact area.*

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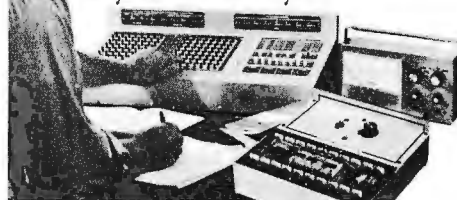
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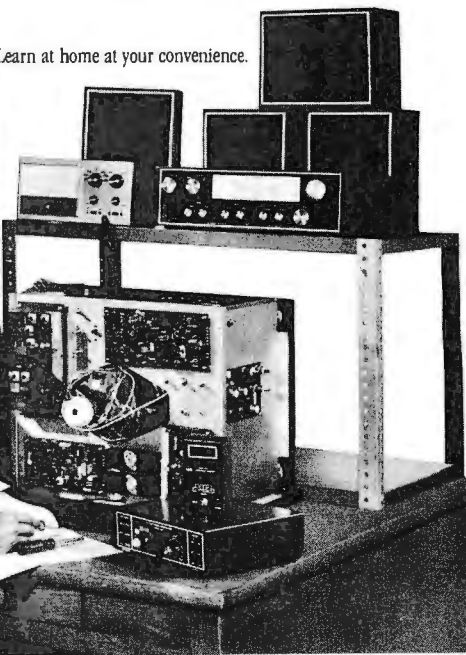
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nents by similarly methodical means. Great? Well, maybe.

Times have changed since this form of installation was considered the last word in speaker-system sophistication. Panel resonances have been discovered, and some of them have been reported to exceed the output of the actual driver by several decibels—in a conventionally designed and executed speaker-system enclosure! A wall or a closet door is not a speaker enclosure. In most cases it is not nearly as stiff and physically inert as it needs to be for this application. I can recall one pathetic instance of a poor chap trying to make part of the crawl space under his eaves serve as an enclosure. After doing everything he could to keep the wall from "taking off" at its own particular set of resonance frequencies he finally bought a pair of already-enclosed speaker systems and built them into the crawl-space areas. Evidently he built them in too solidly because the wall *still* took off in much the same way. The only reasonable solution was to dig the systems out and use them free-standing in the room, just as almost everybody else does.

But this is not necessarily meant as discouragement. There would seem to be some very persuasive advantages to built-in systems of this type. However, there are also unpredictables.

**Walking the Wild Side.** You can't readily buy a speaker system incorporating something like Electro-Voice's 30-inch woofer designed for the discontinued Patrician II, but according to last report you *can* still buy the woofer itself. This is about the heaviest artillery available for sound reproduction, and it enjoys considerable popularity in overseas markets as a subwoofer. Sometimes it is installed in the ceiling so that it can use the entire room above as an enclosure. Since most recordings do not incorporate much information below about 40 Hz (and most music doesn't, either), the capabilities of such an enormous device are not going to be realized very often, except in the reproduction of noise from record warps and faulty disc electroforming. Still, for those who make their own master tapes or listen to material of comparable quality, an almost unlimited low-frequency response has proved useful in recapturing the full sense of the reality of the original event. There are even those who say that it's very essential.

You'll wind up paying many hundreds of dollars to buy the Electro-Voice behemoth

(or its 24-inch Hartley counterpart), enclose it, and work out a crossover network that will properly interface it with the rest of your system. It's not a bad idea if you can afford it, and if the most arresting sense of sonic reality is what you're after. But be warned that typical recorded material is going to be a limiting factor, and that anything found below 40 Hz on most records is going to be something you'd probably rather not hear anyway.

As regards other do-it-yourself monstrosities, it strikes me that most of them are best left undone. A discotheque in the Roppongi district of Tokyo is about as far as you can go in this direction. Internally it has been plaster-formed in a cave-like shape, and embedded in virtually every available surface is a mid-range or tweeter, usually of the compression type and fitted with a flared horn. It is truly a junkyard of speakers, and it sounds like it.

If you pay over—to be on the conservative side—\$300 apiece for a pair of good loudspeakers today, and fit them with an amplifier of suitable (high) power, you are going to be able to generate sound levels you won't be able to stay in the room with, provided you don't live in a cathedral. And the sound will be—or should be—good.

**State of the art?** There are two ways of designing a state-of-the-art speaker system: listening or measuring. The former has generally been the better up to now, but the latter shows signs of catching up.

Some years ago a friend of mine decided to try this approach; and since he was a not-very-distant neighbor, I had an occasional chance to look in and see how he was going about it. First he bought or otherwise laid hands on just about every driver in existence—surely an investment of several thousands of dollars. Then he started testing these drivers, mostly by setting them up in various configurations and inviting people in to listen, but also by playing them to a microphone and examining the results on an oscilloscope. All of this was immensely time-consuming and requiring of the closest concentration. Occasionally, this chap could be seen carrying a battered set of LPs, most of them remarkable for their bad sound, to the home of a friend who had just acquired some exotic new speaker he hadn't had a chance to hear. (His deliberate choice of bad-sounding records is interesting in itself. A good record sounds like music,

and one tends to listen to it as music and overlook any deficiencies in the reproduced sound. But a really bad record—one that has been over-equalized and/or grotesquely miked and mixed—sounds like a parody of music. Then provided one is sufficiently familiar with the record, it is possible to be very objective about just how accurately that badness is reproduced.)

Ultimately the speaker got built, and today it is generally considered to be among the best sound-reproduction devices that any reasonable amount of money can buy. Could any of us mere mortals hope to duplicate this design feat? I think so, given enough time. My friend's engineering credentials, practical experience, and highly developed intuition for this sort of work surely speeded up the process considerably, but all he really did was listen to his speakers *and* listen to the opinions of others he played them for. The applied engineering that went into the project could be duplicated by anyone who read the appropriate books and technical journals with an alert mind. However, the basic engineering seems to be a great deal less than the whole story, as is eloquently demonstrated by the great horde of available speakers that do not really give much pleasure to some people but were created by first-rate engineers in first-rate laboratories.

However, this designer had something else going for him as well: a "master plan." He had an idea in mind that had been overlooked or underemphasized by other speaker designers. If you're looking for a similar plan, here are some ideas that are up for grabs.

(1) Speaker systems are not necessarily designed from the bottom up these days. Dealing with the woofer and its enclosure requirements has now become more of a science than an art, and there are numerous computers that will come up with the magic numbers in no time. Matching the low-frequency part of the system to your listening room remains the greatest impediment to optimum results.

(2) As you consider what drivers you're going to use for the midrange and tweeter portions of the system (we'll assume you're aiming for a three-way system, that being somewhat easier to control in the critical midrange area than a two-way), consider dispersion and resonance characteristics of the individual drivers. Unless you have instruments above and beyond those at the disposal of the typical home constructor, you're





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going to have to rely on guesswork and manufacturer's advice here. But the essential idea is to limit each driver's operating range to frequencies no higher than an octave below the point at which a major diaphragm-breakup mode sets in, and to wavelengths no shorter than those that can be adequately dispersed by the effective radiating area of the driver's diaphragm. According to many experts, strict attention to these rules will result in a "seamless" transition between midrange and tweeter. And, of course, the farther you can keep away from the problematic higher frequencies the better.

Also, naturally, you'll have to consider the driver's low-frequency limitations, essentially dictated by its excursion capabilities as translated into acoustic output. (You didn't think this business was going to be easy, did you?)

(3) The simplest possible crossover network is likely to be the best, according to many authorities, because it will keep the acoustic phase angle between drivers relatively smooth in transition. The trouble is that the simplest crossover network will give you a mere 6-dB-per-octave rolloff, which means you'll pay a price in various types of distortion unless you can keep well away from the troublesome higher frequencies mentioned above. Here it becomes necessary to make certain difficult design decisions. The best decision should, in theory, result in the best loudspeaker.

And, oh yes, don't make the mistake of believing that any two drivers of the same make and model will perform identically. They often won't.

(4) Once you have decided on which enclosure principle you're going to use for the woofer, you should be able to get adequate guidance on its construction from the manufacturer. The rest is carpentry. But two factors are critical. The first is to make the box just as stiff and inert as possible. The second is to make it virtually disappear as far as the midrange and tweeter are concerned. Many experts now agree that acoustic diffraction effects are one of the major causes of loudspeaker coloration. You can combat these by eliminating all edges, moldings, and other sharp transitions in the cabinetry, and by generally keeping the whole thing out of the radiation pattern of the higher-frequency drivers.

There are other matters to be considered as well, but their acoustic significance is not so well established. If you can master just the above you'll be off to a very good start. Good luck!





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# Julian Hirsch

## Audio Report

### Dolby FM Broadcasting

**I**T HAS been more than five years since Dolby-B processing was first used in FM-stereo broadcasting. Unlike the case with cassette recording, where Dolby-B noise reduction has been almost universally accepted, relatively few FM stations have opted for the Dolby system, and correspondingly few stereo receivers have the built-in Dolby processors needed to realize its benefits. Although most audio hobbyists have some understanding of the purpose of Dolby-B processing in tape recording and playback, there is still widespread confusion about its role in FM broadcasting. The problem is aggravated by some genuine differences between the two situations.

In the case of tape recorders, the problem is the degradation of signal-to-noise ratio (S/N) in the recording and playback process, resulting from the hiss inherent in the tape medium itself. The Dolby-B system boosts the high frequencies during recording and attenuates them in a complementary manner during playback. The net result is an unchanged frequency response, insofar as the program itself is concerned, with a net reduction of the hiss added during the record/playback process.

The amount of boost and cut (and to some extent, the frequencies affected) are a constantly varying function of signal level. The strong signals are unmodified, and progressively larger amounts of boost and cut are introduced as the level decreases. The total effective noise reduction at high frequencies beyond about 5000 Hz is typically 10 dB in a properly adjusted Dolby-B system. (The Dolby-A system, used in professional recording, is similar in principle but operates over the entire audio range in several frequency bands.) The operating time constants, signal levels, and other circuit operat-

ing details are rigorously defined in Dolby patents and licensing agreements, so that a Dolbyized tape made on one recorder can be played back correctly on any other Dolby-equipped machine.

The FM broadcaster faces a somewhat similar, yet different, problem. Noise, of course, is introduced in the transmission/reception process, and in the fringe areas of reception the background hiss can ultimately limit the public's enjoyment of a program. Traditionally, FM broadcasters tend to modulate their transmitters at the highest possible level consistent with distortion and the creation of interference on nearby channels. Since the highest audio frequencies in a program are usually at a much lower level than the middle and low frequencies, the FM transmission is preemphasized, or boosted, at high frequencies with a 75- $\mu$ s time constant (a 6-dB/octave boost above 2120 Hz).

In an FM receiver, there is a complementary 75- $\mu$ s deemphasis, rolling off the response of the detected program at 6 dB/octave above 2120 Hz. The reduction in noise, compared to "flat" transmission and reception, is about 11 dB. At the time when these standards were established, there was little problem with excessive high-frequency program material. Today, the situation is different, and the amount of high-frequency energy present in the recorded program material could easily overmodulate a transmitter, causing distortion and interference.

Reducing average program levels by about 5 dB could eliminate much of this problem. However, no FM broadcaster wishes to sound weaker than his competition, and this would also reduce the overall S/N ratio by the same amount. The most common solution is

*"The benefits of Dolby FM are rarely as dramatic as those in cassette recording . . . because the system is so compatible with existing FM practice."*

(Continued on page 30)



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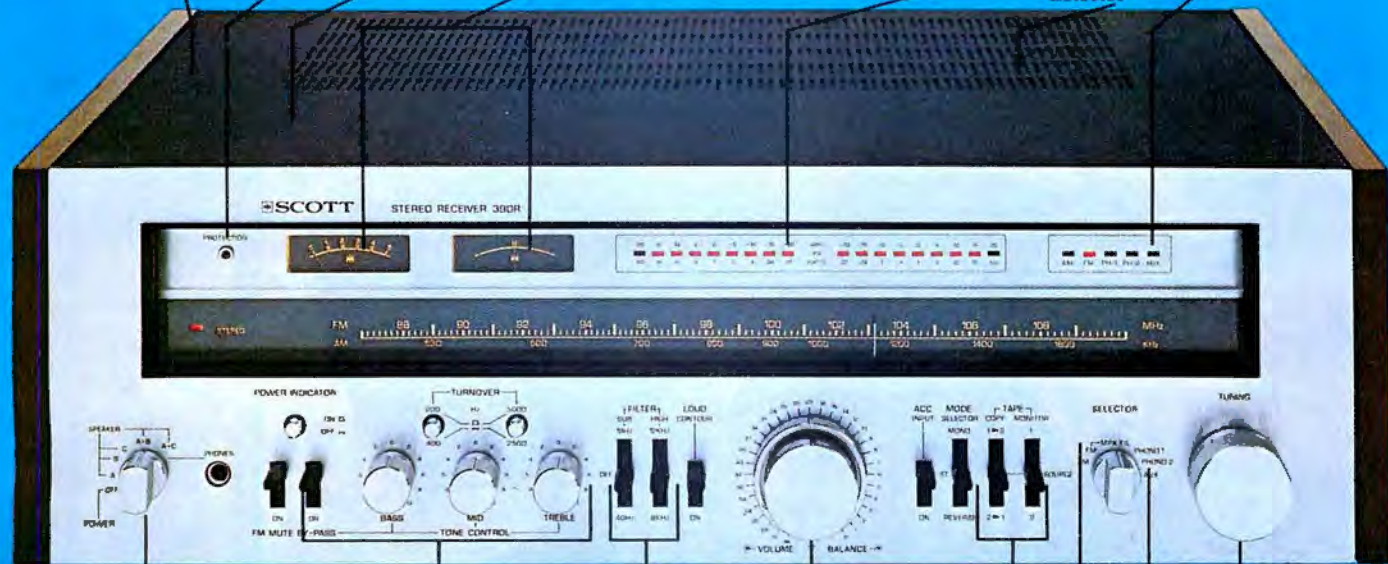
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to use some form of dynamic high-frequency peak limiting to prevent excessive deviation at the high frequencies while retaining a high average modulation level. The "price" exacted by this technique is a loss of natural quality and openness in the received sound. In many cases, this effect is so severe as to destroy the appeal of the program to any truly serious music listener.

It was to this overall problem that Dolby Laboratories addressed itself in its adapting of the Dolby-B system to FM broadcasting. The hardware and its operating characteristics were already developed and in wide use. The major problem that faced Dolby engineers was compatibility with receivers lacking Dolby decoding circuits, which, at the time, was virtually all the FM receivers then in existence!

Cassette tape users have learned that a Dolby tape *can* be played without decoding, but it will sound undesirably shrill and bright and noisy. Some treble rolloff with tone controls can make such a program listenable, but this is hardly a satisfactory solution for a medium so widely used as FM broadcasting. Although the Dolby system, in principle at least, should be able to replace the fixed preemphasis and deemphasis now in use, it would obviously be impractical to eliminate the preemphasis at the transmitter. Such a program, when heard through any ordinary FM receiver, would sound unacceptably dull and lacking in highs (the response would be down 13.8 dB at 10,000 Hz). Ultimately, Dolby decided that a combination of B-type encoding and a 25- $\mu$ s preemphasis characteristic at the transmitter would be the most desirable compromise. This would boost the highs above 6360 Hz at 6 dB per octave and greatly reduce the possibility of high-frequency overmodulation. Heard on a conventional receiver with 75- $\mu$ s deemphasis, the loss of highs resulting from the added high-frequency rolloff in the receiver would be approximately compensated by the added brightness from the Dolby process. The latter is dynamic and differs with signal level. The former is fixed, but it was empirically determined

that the combination was satisfactory. In extensive trials, most listeners were not aware of any change in transmission characteristics when listening to such programs on their conventional receivers.

The listener with a Dolby-equipped receiver will also have a 25- $\mu$ s deemphasis time constant, which is usually selected by the same switch that turns on the Dolby system. Thus, his received program will have the correct "flat" frequency response *before* it enters the Dolby decoder, whose action is devoted to its principal task of noise reduction. Some receivers have a switch that changes the deemphasis from 75 to 25  $\mu$ s but require the use of an external Dolby-B decoder. There are also inexpensive accessories that can change the effective deemphasis externally for adapting older receivers to add-on Dolby units.

In the transmission of a Dolbyized signal, the 10-dB S/N improvement of the Dolby-B system is divided approximately equally between noise reduction and an increase in average program level. The change to a 25- $\mu$ s preemphasis makes it possible to raise the average program level a few decibels or/and to dispense with high-frequency limiting. The dynamic range of a program will be typically increased by about 5 dB at the high-level end, and the noise level in reception will be reduced by about the same amount, for a total improvement of 10 dB.

About 180 stations in the United States are equipped for Dolby-B transmission. Most metropolitan areas, and many rural areas, are served by one or more of these stations. The benefits of Dolby FM, however, are rarely as obvious or dramatic as those of Dolby-B in cassette recording. Ironically, this is because Dolby has been so successful in making the system compatible with existing FM broadcast practice. A Dolbyized broadcast sounds quite conventional on a non-Dolby receiver. Stations rarely, if ever, identify themselves as using Dolby noise reduction. Published FM schedules and programs never mention the existence of Dolby. No tell-tale signal, such as the stereo pilot carrier, is present to switch the receiver's Dolby cir-

cuits on or alert the user to the presence of a Dolby transmission. (We understand that Dolby Laboratories has developed such a system that may be put into use in the near future.)

Since the user rarely knows, in the absence of other information, whether a particular signal is Dolbyized, how is he to know when to turn on his receiver's Dolby circuits? The answer, sad to say, is that he cannot know. We have used a number of Dolby-equipped receivers, the most recent being the Lafayette Model LR-120Db, reviewed this month, and have always been disturbed by the difficulty of deciding whether or not a signal requires Dolby decoding. In our area, three stations are listed by Dolby as using their system. Much of the time, we hear little or no change in their programs when changing from 75- $\mu$ s without Dolby to 25- $\mu$ s with Dolby reception. Sometimes the sound is slightly softer and less bright with Dolby, as one would expect it to be, and sometimes the hiss level is audibly reduced. Since the relative audibility of these effects is a function of program content, instantaneous program level, and received signal strength, it is really quite difficult or even impossible to predict the audible benefits of Dolby reception. To be sure, in some cases we have heard an improvement in sound almost as dramatic as that achieved by Dolby in a typical cassette deck. Unfortunately, there is no way to predict such a result.

The Lafayette Model LR-120Db fell between the extremes mentioned above. If we oriented the antenna to get a slightly hissy background on one of the local Dolby stations, the improvement in S/N was quite noticeable. On the other hand, with fully limiting signals, there was no change whatever when the Dolby system was used, except the slightly softer quality resulting from its dynamic frequency-response effects.

Dolby does not expect that the Dolby-B system will ever be adopted by a large segment of the U.S. FM broadcast industry. It presupposes a strong concern with sound quality and an audience that shares that concern. Stations that specialize in rock and most popu-



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**Resistance:** 0.1  $\Omega$  to 20 M $\Omega$  in 6 ranges (Basic accuracy 0.1%  $\pm$  1 digit)

**Diode Test Current:** 0.1  $\mu$ A, 10  $\mu$ A, 1mA, in 3 ranges

**ACV Frequency Response:** 40 Hz to 40 kHz (40 Hz to 1 kHz on 1 kV range)

**Input Impedance:** 10 M $\Omega$

**Input Overload Protection:** 1200 VDC or RMS on all voltage ranges; 250 V (DC or RMS) and fuse-protected on  $\Omega$  and current ranges

**Power Requirement:** 4.5 to 6.5 VDC (4 "C" cells)

Optional nickel-cadmium batteries or AC adaptor/charger.

**Display:** 0.36" (9.2 mm) 7-segment LED

**Size:** 8" W x 6.5" D x 3" H (203 x 165 x 76 mm)

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PE-12



lar music are not likely to make the investment in Dolby encoding equipment, nor would their listeners appreciate such a move. Clearly, if one lives in an area not served by a Dolby station, or if one has no

interest in the programming of such a station, it would be difficult to justify a substantial additional investment for the Dolby circuitry in a receiver. Fortunately, the availability of Dolby-B integrated

circuits has made it possible to include this feature without an unreasonable cost penalty, as illustrated by the Model LR-120Db and a number of other receivers recently introduced. ◇

# audio test reports:

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receiver  
ever to bear  
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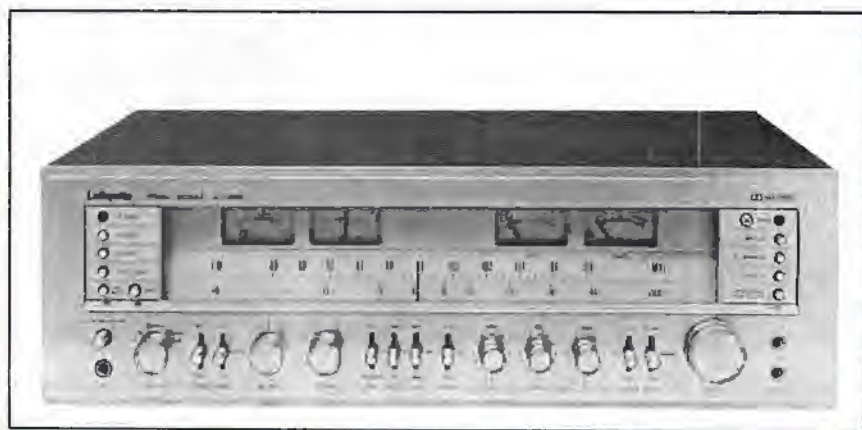
The Model LR-120Db stands at the top of Lafayette's line of AM/FM stereo

receivers and is the finest receiver ever to bear the Lafayette name. It is rated in accordance with FTC regulations to deliver 120 watts/channel into 8 ohms from 20 to 20,000 Hz with no more than 0.09% THD. Among its many features are built-in Dolby noise-reduction FM decoding circuits, triple tone controls with selectable turnover frequencies, adjustable FM muting threshold, and mixing microphone input.

The receiver measures 21"W x 17"D x 7"H (53.3 x 43.2 x 17.8 cm) and weighs 60 lb (27.3 kg). The receiver is catalog priced at \$649.99.

**General Description.** Most of the upper two-thirds of the receiver's front panel is dominated by a glass window behind which are AM and FM tuning scales. Also behind the window are separate center-channel and relative-signal-strength tuning meters and two output power meters calibrated from 0.1 to 120 watts into 8-ohm loads. The dial scales are tilted back slightly for maximum visibility.

To the left of the dial window is a vertical column of small pushbutton switches and a red FM STEREO indicator. One button is used to engage and disengage the Dolby system. The next is for blending the high frequencies to reduce noise on weak stereo signals with no loss in high-frequency response. The next button permits the receiver to be switched between the



an impressive combination  
of features and performance in  
the Lafayette Model LR-120Db  
AM/FM stereo receiver

automatic mono/stereo and mono-only modes. The FM MUTE button at the bottom must be out to obtain muting action. Near the FM MUTE button is a small rotary control that permits a wide muting threshold range.

To the right of the dial window is another vertical column of pushbutton switches. At the top are the POWER

smooth handling  
makes it a  
pleasure to operate

switch and its power-on indicator. Below the POWER switch are separate pushbuttons for switching in and out three pairs of speaker systems, only two of which can be in the circuit at any given time. The bottom button allows the sensitivity of the power meters to be increased to indicate power

levels between 0.01 and 24 watts.

Across the bottom of the panel are the main operating controls of the receiver. At the left are a MIC (microphone) jack and a PULL ON/MIC LEVEL control. The control is used for varying the gain of the microphone amplifier, which is turned on by pulling out on the control's knob. The next control, the input SELECTOR, has positions for AM, FM, PHONO 1, PHONO 2, and AUX. The two PHONO positions are for magnetic phono cartridges.

Lever switches for tape monitoring from either of two tape decks are provided for controlling and cross-connecting the decks for dubbing from one deck to the other. To the right of the tape switches are the BALANCE (detented) and VOLUME controls.

Three lever switches control the loudness compensation and two filters. There are two switch-selectable loudness compensation modes. In





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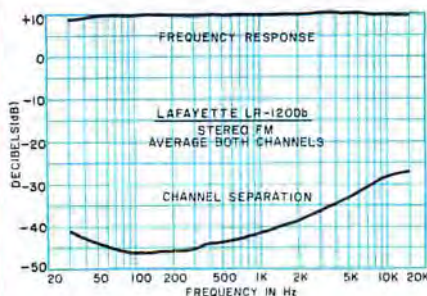
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one, only the low frequencies are boosted as the VOLUME control is turned down; in the other, both low and high frequencies are boosted. Each filter switch has separate positions for OFF and two turnover frequencies. The selectable turnover frequencies for the LOW filter are 15 and 70 Hz and 7000 and 12,000 Hz for the HIGH.

The BASS, MID, and TREBLE TONE controls have 11 detented positions. Adjacent to the BASS and TREBLE controls are lever switches for removing the controls from the circuit or changing their turnover frequencies (250 and 500 Hz bass and 2500 and 5000 Hz treble). The MUTE switch can be used to reduce the audio gain by either 15 or 30 dB. To the right of this switch is the large TUNING knob and two (head) PHONES jacks.

The receiver's rear apron contains the various input, speaker, and antenna connectors and slide switches that provide a choice of 2.5-, 5-, or 10-mV phono sensitivity and attenuate the input signal from the antenna to prevent overloading from strong local stations. Also on the rear apron are a hinged AM ferrite-rod antenna and a pair of



*Averaged frequency response and crosstalk for both channels.*

accessory ac outlets, one of which is switched. Finally, the output-transistor heat sinks extend about 2" (5.1 cm) from the rear of the receiver and occupy a big portion of the rear apron.

**Laboratory Measurements.** Following the one-hour preconditioning period, which caused the heat sinks of the output transistors to become uncomfortably hot, the outputs clipped at 156 watts/channel at 1000 Hz into 8 ohms (an IHF clipping headroom rating of 1.13 dB). The dynamic headroom was 1.49 dB, with a maximum short-term output of 169 watts.

The 1000-Hz distortion was un-

measurably low at very low power levels. It rose smoothly with increasing power to 0.028% at 120 watts and 0.04% at 150 watts. The IM distortion was 0.02% at 1 watt, 0.14% at 120 watts, and 0.17% at 150 watts. The THD was a maximum of 0.05% at 20,000 Hz at the rated output power. It was typically between 0.025% and 0.03% at low and middle frequencies. At reduced outputs, the distortion was still lower, typically measuring less than 0.02%.

Input sensitivity for a 1-watt output was 14 mV through the AUX inputs and 0.4 mV through the PHONO inputs with 5-mV sensitivity. The A-weighted noise level was -74.2 dB and -73.5 dB, referred to 1 watt, through the AUX and PHONO inputs. The phono preamplifier overloaded at a very high 400-mV input at 1000 Hz and at 2.4 volts at 20,000 Hz. The latter figure is equivalent to 250 mV at 1000 Hz, which is thus the IHF rated maximum phono input. These figures would be halved with the 2.5-mV phono sensitivity setting and doubled with the 10-mV setting. The phono input resistance was 100,000 ohms, which is higher than the recommended load for

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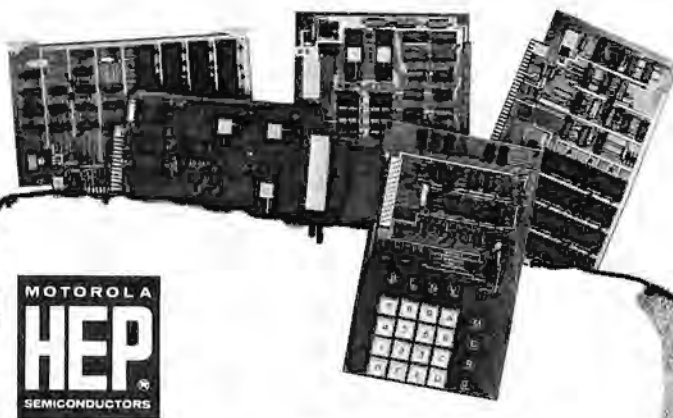
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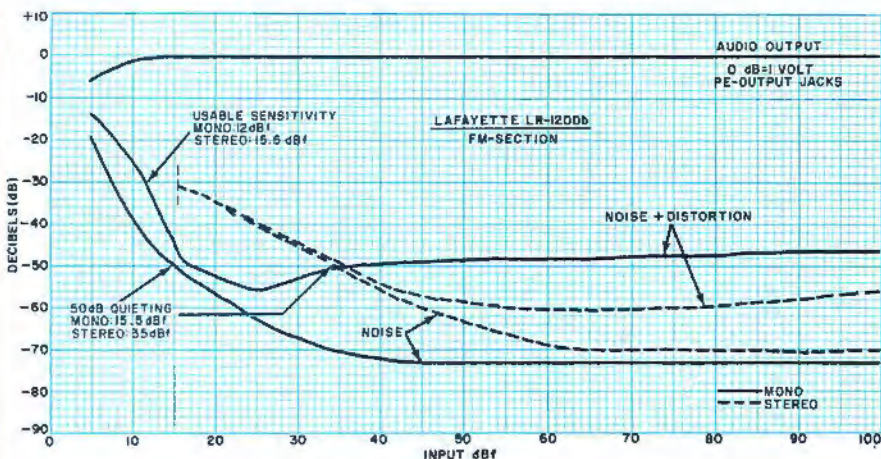
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most cartridges, and capacitance was 175 pF.

Frequency response was within  $\pm 0/-1$  dB from 20 to 20,000 Hz through the AUX inputs. The RIAA phono response was  $\pm 0.5/-3.5$  dB from 30 to 15,000 Hz, with the decrease at the low-frequency end. It decreased to  $-5$  dB at 20 Hz. The apparent high-frequency equalization changed appreciably when it was measured through the inductance of a phono cartridge, revealing a 2.5-dB increase in output at 20,000 Hz. Most of this change was caused by the 100,000-ohm input resistance, since our measurement is based on the use of a standard 47,000-ohm input termination. Nevertheless one would expect a magnetic phono cartridge to sound slightly bright, since the extreme high-frequency response of most cartridges is enhanced when they are terminated in a higher-than-normal load resistance.

The tone controls could provide an almost infinite variety of response curves. With the 250- and 5000-Hz turnover frequencies, they were able to correct the system's response at frequency extremes with virtually no



Noise and sensitivity curves for FM section of receiver.

effect in the midrange. Responses of the filters were approximately as rated, with 6 dB/octave slopes in the bass and 12 dB/octave slopes in the treble. The unit's loudness compensation could be used with better-than-average effectiveness, since the audio MUTE switch could be set to permit the VOLUME control to be operated at a reasonably high setting. This avoids the excessive heaviness that mars the sound of most loudness controls. The power meters, like most such indica-

tors, gave only approximate readings. Typical errors were from 10% to 50%, except at very low outputs, where they were several hundred percent.

Performance of the FM tuner section was generally very good. Our test unit had an apparent misalignment that caused its mono distortion to be several times as high as its stereo distortion, but this was the only respect in which the tuner performance fell short of excellence.

In mono, IHF usable sensitivity was

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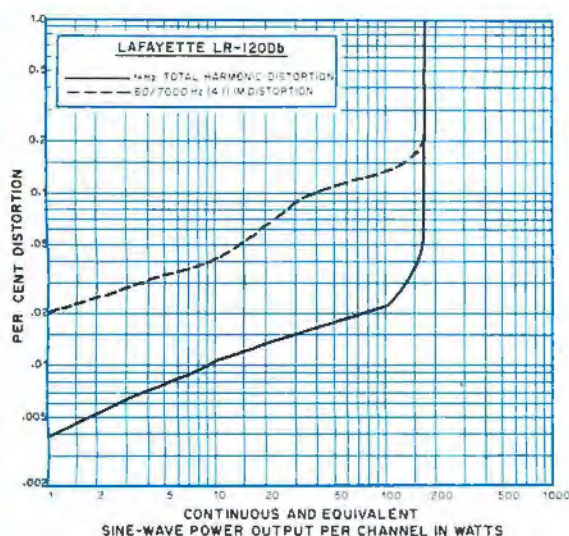
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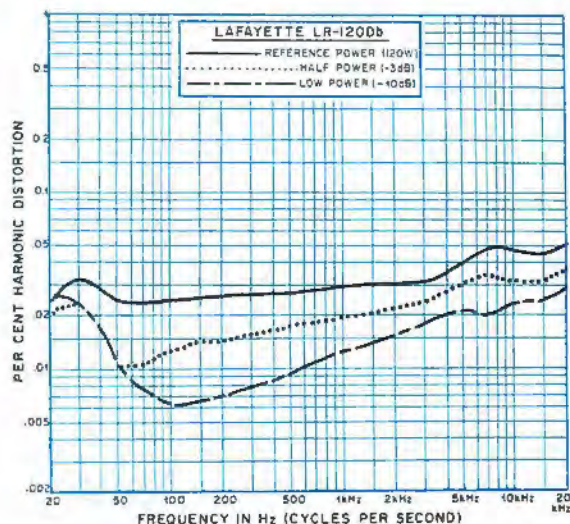
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Total harmonic distortion at 1 kHz and 60/7000-Hz distortion.



Harmonic distortion at three power levels.

12 dBf; stereo sensitivity was set by the switching threshold at 15.5 dBf. The more meaningful 50-dB quieting sensitivity was 15.5 dBf in mono and 35 dBf in stereo. The mono THD + N was 0.4% at a 65 dBf input, though it was necessary to detune the receiver considerably to get the distortion down to this level. In stereo, the distortion was a very low 0.1% with the tuning meter set to its center. The respective unweighted S/N readings were 72.5 and 70 dB.

Stereo frequency response was within +0.6/-0.8 dB from 30 to 15,000 Hz. Even with its flat response at the high end, the pilot carrier component in the receiver's audio was suppressed to an almost unmeasurable -80 dB. And the tuner's hum was a very low -75 dB. Stereo channel separation was in the 50-to-56-dB range between 30 and 1500 Hz. It reduced to 37.5 dB at 15,000 Hz.

The capture ratio of 1.25 dB was slightly better than the rated 1.3 dB. AM rejection was 60 dB at a 45-dBf input and 72 dB at a 65-dBf input (it is rated at 55 dB). The image rejection and alternate-channel selectivity, both rated at 80 dB, were respectively 75.6 and 79.4 dB. Adjacent-channel selectivity was 5.8 dB. The muting threshold was adjustable from a minimum of 26 dBf drop-out and 29 dBf turn-on levels to 44 and 49 dBf, respectively.

The AM tuner section's frequency response was very limited at both high and low frequencies, being down 6 dB at 270 and 3400 Hz.

**User Comment.** The Model LR-120Db offers a most impressive combination of operating features and

## Performance Specifications

Specification	Rating	Measured
<b>Audio</b>		
Power output	120 W/ch into 8 ohms, 20-20,000 Hz, less than 0.09% THD	Confirmed
Hum and noise (A weighting)		
Phono	Over 70 dB (re 120 W)	73.5 dB (re 1 W)
Aux.	Over 90 dB	74.2 dB
Input sensitivity		
Phono	2.5, 5.0, 10 mV	Confirmed
Aux.	150 mV	
Phono overload	150 mV at 1000 Hz with 0.1% THD	250 mV (20 kHz, re 1 kHz)
<b>FM Section</b>		
Usable sensitivity		
Mono	10.3 dBf	12.0 dBf
Stereo	17.2 dBf	15.5 dBf
50-dB quieting		
Mono	14.1 dBf	15.5 dBf
Stereo	36.8 dBf	35 dBf
S/N at 65 dBf		
Mono	74 dB	72.5 dB
Stereo	70 dB	70 dB
Frequency response (30-15,000 Hz)	+0.5/-1.5 dB	+0.6/-0.8 dB
Distortion at 65 dBf		
Mono	0.15%	0.40%
Stereo	0.30%	0.10%
Capture ratio at 65 dBf	1.3 dB	1.25 dB
Image response	-80 dB	-75.6 dB
AM suppression	-55 dB	-72 dB
Alt. channel selectivity	80 dB	79.4 dB
Stereo separation		
100 Hz	45 dB	56 dB
1000 Hz	48 dB	51.5 dB
6000 Hz	42 dB	42 dB
Subcarrier product ratio	60 dB	80 dB

electrical performance, especially for a receiver in its price range. Its smooth handling, excellent sound quality, and such niceties as a noiseless, thump-free muting system,

dial calibration  
was exact and  
tuning was  
unambiguous

made the receiver a pleasure to operate. The FM-Dolby decoder worked well on the stations in our locality that

employ the Dolby system.

FM dial calibration was exact on the lower half of the band and within about 100 kHz on the upper half. The tuning was unambiguous, too, for lowest noise and distortion with the meter pointer at its center-channel position. The tone controls were certainly as versatile as anything short of a multi-band equalizer. If the phono sound is too bright (as could happen with some cartridges), it might be desirable to connect a 100,000-ohm resistor across each output of the cartridge to provide a normal 50,000-ohm termination.

Most of our criticisms are minor. Labelling of the pushbutton controls is contrary to normal practice, for example. Whereas pressing a button in commonly produces the indicated result, the converse occurs with the FM MUTE button. Muting is *disabled* when it is pressed in. Also, the muting threshold is too high at all settings of the variable control.

These minor observations aside, we feel that the Lafayette Model LR-120Db is just about the "most" receiver for the money that we have seen and tested in the current market.

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## convenient editing functions mark the front-loading Dual Model C 819 cassette deck

accurate recording  
with foolproof  
level meters and  
low flutter



The Dual Model C 819 cassette deck has many of the operating details and performance qualities of the company's higher-priced Model C939. Unlike the Model C939, however, the Model C 819 is a front-loading deck. It has a

FADE EDIT function that allows one to edit out unwanted portions of a recorded program while listening to the tape playback.

Other features in the Model C 819 cassette deck include: peak-indicating level meters that monitor the signal levels *after* the recording equalization; a MEMORY WIND system that stops the tape when the index counter reaches 000 in both fast forward and rewind; microphone inputs that can be mixed with the line inputs; and bias and equalization selectable for ferric-oxide, chromium-dioxide, and ferri-chrome tape.

The deck measures 17½"W × 13¼"D × 5 7⁄8"H (43.5 × 33.7 × 14.9

cm) and weighs 17 ¾ lb (8.1 kg). Its suggested retail price is \$430.00.

**General Description.** The tape transport is located at the left of the front panel. Piano-key-type transport-control levers are below the cassette compartment.

Operating the EJECT key causes the viscous-damped, top-hinged cassette door to swing open slowly to provide access to the cassette tray. When the cassette door is manually closed, a window in it gives a clear view of the cassette inside the well. The other transport controls can be operated in any sequence without having to go to STOP. However the tape must be motionless before the RECORD lever can be engaged.

At the right of the front panel are two level meters whose highly visible scales are calibrated from -20 to +3 dB. The fast-responding peak-indicating meters have a long decay time. Below the meters are two pairs of concentric recording-level controls for the MIC and LINE inputs, the two microphone jacks, and a recessed button labelled FADE EDIT. To use the FADE EDIT button, a plastic door covering it must be raised. With the deck operating in the playback mode, the user presses in and holds the button for as long as he wishes to erase the tape. The FADE EDIT function gradually increases the erase current over a period of 3 to 5 seconds to remove the recorded program smoothly. Releasing the button allows the erase current to decrease gradually to zero over a 3-to-5-second period, giving a smooth transition to the following portion of the program.

When a microphone is plugged into only one of the input jacks, its signal



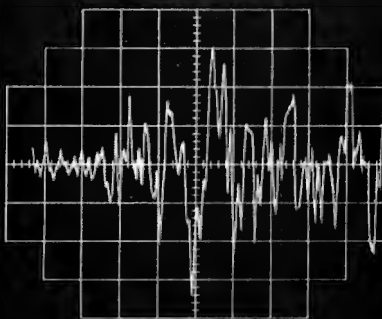
# What 0.02% THD doesn't tell you about the SE-9060, waveform fidelity will.



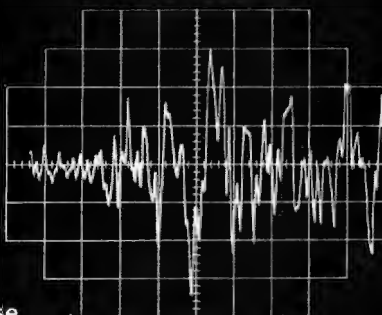
THD as low as 0.02% says a lot about any amplifier. But oscilloscope readings show it all. Look at the waveforms. The output waveform of the SE-9060 is virtually a mirror image of the input.

One way Technics achieved this goal was with dual FETs in the differential amplifier. They give the SE-9060 the DC stability necessary for the highest gain in the crucial first stage. While the constant current load and current feedback used in the voltage amplifier keep distortion to a minimum.

And since the SE-9060 is a DC amplifier, each amplifier section and the NFB loop are directly coupled without the use of any capacitors. So the SE-9060 not only has virtually nonexistent phase shift, it also boasts flat frequency response from DC to 100 kHz. And with completely



Input Waveform.



Output Waveform.

independent power supplies for each channel, Technics eliminated all signs of transient crosstalk distortion.

Compare specifications. And you'll realize there's no comparison.

**POWER OUTPUT:** 70 watts per channel (stereo), 180 watts (monaural) minimum RMS into 8 ohms from 20 Hz to 20 kHz with no more than 0.02% total harmonic distortion.

**POWER BANDWIDTH:** 5 Hz-50 kHz, -3 dB. **S/N:** 120 dB (IHF A). **RESIDUAL HUM & NOISE:** 100  $\mu$ V. **INPUT SENSITIVITY & IMPEDANCE:** 1 V/47 kilohms. **INTERMODULATION DISTORTION** (60 Hz: 7 kHz, 4:1): 0.02%. **FREQUENCY RESPONSE:** DC ~ 100 kHz, +0 dB, -1 dB.

Technics SE-9060. A rare combination of audio technology. A new standard of audio excellence.

**Technics** Professional Series  
by Panasonic

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## Product Focus

The FADE EDIT feature of the Dual Model C 819 is a convenient solution to the problem of "editing" a cassette tape electronically. As often happens when a commercial announcement or other unwanted material is recorded together with a desired program, it is customarily removed by playing the tape up to that point, and placing it into the record mode with no input signal for the duration of the unwanted material. The abrupt cessation of the recorded program, and its equally abrupt return, can introduce a jarring note into the final recording.

Dual's FADE EDIT circuit applies a current to the erase head while the machine is in its playback mode, and does so in a smooth and nonjarring manner. The bias/erase oscillator is normally turned on by mechanical switches when the machine is placed into its recording mode. (A red LED across the dc supply line to the oscillator glows when it is powered to show that a recording is in progress.) In the Model C 819, a Darlington transistor pair, in series with a diode, is connected across the mechanical switch contacts in the oscillator's dc supply circuit. Normally, the gate of the input transistor is returned to ground through a parallel combination of a 22- $\mu$ F capacitor and a 120,000-ohm resistor. In this condition, the stage is nonconducting and has no effect on the operation of the deck.

When the FADE EDIT button is held in, the input gate is connected to the +24-volt power supply through a parallel combination of 4.7- $\mu$ F and 220,000 ohms. As

the capacitor from gate to ground charges, the transistors begin to conduct and an exponentially increasing positive supply voltage is applied to the erase oscillator. The REC LED simultaneously begins to glow faintly, and a gradual erasure of the tape begins.

About five seconds is required for the output of the erase oscillator to reach its maximum amplitude (and the LED its full brightness). Since the tape is being played back while this is happening and the erase head precedes the record/playback head in the tape path, one hears the program smoothly fading away. The time for total erasure depends on the kind of tape being used, but is typically in the range of 3 to 5 seconds.

When the FADE EDIT button is released, the transistors are fully conducting. The charge on the 22- $\mu$ F capacitor in the gate circuit drains off to ground through the shunting 120,000-ohm resistor and the Darlington stage slowly shuts off. As this happens, the REC LED dims, and the original program on the tape begins to emerge from a silent background. Like the erase process, the fade-in takes a few seconds.

Although this technique still calls for careful timing of the portion of the tape to be erased, it is much smoother and more foolproof than the former method of placing the deck into its recording mode. When used carefully, it makes it possible to assemble an edited tape with a professionally smooth transition from one section to another.

**Laboratory Measurements.** The user's manual for the cassette deck lists a number of tapes suitable for each of the bias and equalization switch settings. Our test deck had been adjusted by United Audio (the importer) for Maxell UD-XL I for Fe, Scotch Master II for Cr, and BASF Professional III for FeCr. We used the first two and Sony Ferrichrome tapes in our tests. (We did not have BASF Professional III tape.)

The flattest overall record/playback frequency response was obtained with Maxell UD-XL I tape, which produced a variation of only  $\pm 0.75$  dB from 30 to 15,500 Hz. The low-frequency head contour ripples were relatively small compared to those of most cassette recorders. The response of Scotch Master II tape was not quite as ruler flat, sloping down steadily from 35 to 15,000 Hz. Still, the overall variation, relative to the 1000-Hz level, was a very respectable  $\pm 2.5$  dB from 20 to 14,500 Hz. The Sony FeCr yielded a flat response of  $\pm 1$  dB from 33 to 15,000 Hz.

The tracking of the Dolby circuits was virtually perfect, measuring less than 0.5 dB of difference between the response curves made with and without the Dolby system switched in, at any frequency up to 12,000 Hz and at any level from -20 to -40 dB.

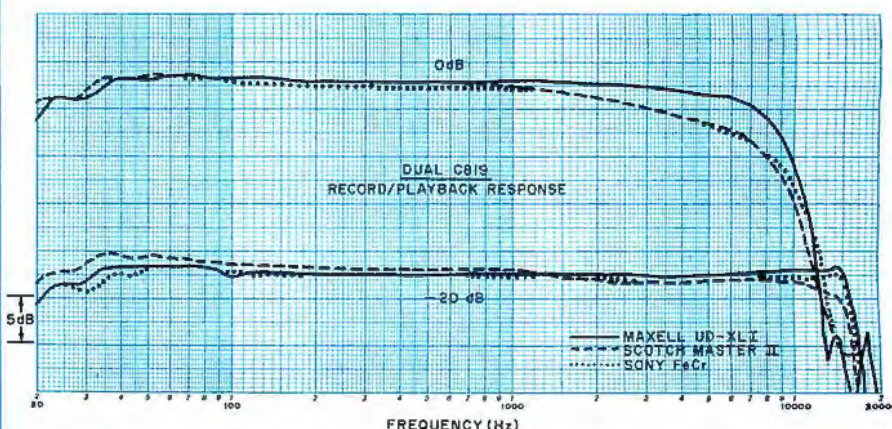
The 120- $\mu$ s playback equalization was measured with a TDK AC-337 test tape. It was within +0.8/-1.7 dB from 40 to 12,500 Hz. The 70- $\mu$ s equalization (for Cr and FeCr tapes) was measured with a Teac 116SP test tape and was within +0.5/-1 dB from 40 to 10,000 Hz.

A line input of 44 mV was needed for a 0-dB recording level. This produced a maximum playback output level of 0.66 volt with Maxell UD-XL I,

can be routed to either channel, as desired. When both jacks are used, the recording is made in stereo. There are screwdriver-adjustable line-output level controls on the deck's rear apron. (The deck has a limiter that reduces the gain almost instantly when a signal peak exceeds 0 dB to prevent distortion.)

The central portion of the front panel contains the index counter, MEMORY WIND button, phone jack and its level controls (separate for each channel), and four pushbutton switches. Two of the switches are for switching in and out the Dolby noise-reduction system and the recording limiter. The other buttons are for setting the bias and equalization, labelled Fe and Cr for the two most popular tape formulations. For ferrichrome tapes, both buttons must be engaged simultaneously. Green and red LEDs on the front panel indicate when the Dolby is in use and when the recording mode is selected, respectively.

### "fade edit" circuit operates smoothly

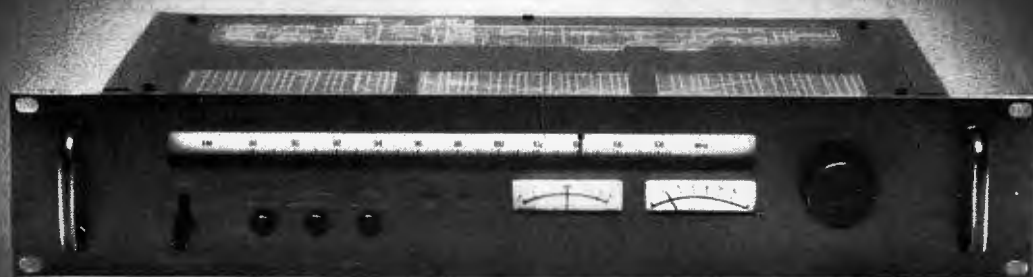


Record/playback responses at 0 and -20 dB for three types of tape.



# The Technics ST-9030 tuner.

Purists would feel better if it cost over \$1,000.



To some, tuners that offer 0.08% THD, 50 dB stereo separation, a capture ratio of 0.8 dB and waveform fidelity should demand a price tag of over \$1,000. But with the ST-9030 this performance can be yours for under \$450.

That's quite a feat for a tuner. But then the ST-9030 is quite a tuner. It has two completely independent IF circuits: A narrow band, for ultra-sharp selectivity. And a wide band, for ultra-high separation and ultra-low distortion. It even selects the right band, depending on reception conditions, automatically.

Both bands give you the same extended flat frequency response. Because, unlike conventional tuners, the ST-9030 utilizes an electronic pilot cancel circuit that cuts the pilot signal, without cutting any of the high end. It's ingenious. And a Technics innovation.

The Technics ST-9030 has one of the quietest, most sensitive front ends of any tuner. With an advanced linear frequency 8-ganged tuning capacitor and 3 double-tuned circuits, plus dual gate MOS

FETs in the 2-stage RF amplifier and balanced mixer circuit. What's more, there's a servo tuning circuit that locks into the tuned frequency, regardless of minor fluctuations. The result: Negligible drift distortion and maximum stereo separation.

Technics ST-9030. Compare specifications. Compare prices. And you'll realize there's really no comparison.

THD (stereo): Wide—0.08% (1kHz). Narrow—0.3% (1kHz). S/N: 80 dB. FREQUENCY RESPONSE: 20Hz—18 kHz +0.1, -0.5 dB. SELECTIVITY: Wide—25 dB. Narrow—90 dB. CAPTURE RATIO: Wide—0.8 dB. Narrow—2.0 dB. IF, IMAGE and SPURIOUS RESPONSE REJECTIONS (98 mHz): 135 dB. AM SUPPRESSION (wide): 58 dB. STEREO SEPARATION (1 kHz): Wide—50 dB. Narrow—40 dB. CARRIER LEAK: Variable —65 dB (19 kHz). Fixed —70 dB (19 kHz, 38 kHz). SUGGESTED RETAIL PRICE: \$449.95\*.

Technics ST-9030. A rare combination of audio technology. A new standard of audio excellence.

\*Technics recommended price, but actual retail price will be set by dealers.

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0.79 volt with Scotch Master II, and 0.59 volt with Sony FeCr tapes. The mic input sensitivity was 0.285 mV. The microphone preamplifier overloaded gradually instead of clipping. The second-harmonic distortion reached 3% with a microphone input of 57 mV. The limiter attacked rapidly and prevented any significant overload or distortion even when the input signal was +20 dB or greater. When the overload was removed, the gain was gradually restored to normal over a period of perhaps 30 seconds.

The 1000-Hz playback distortion reached the 3% reference level with a recording input of +5 dB (Maxell UD-XL I), +2 dB (Scotch Master II), and +3 dB (Sony FeCr). The respective 0-dB playback distortion levels were 0.63%, 2.0%, and 1.6%. The unweighted S/N for the three tapes was 54.5 dB (UD-XL I), 51 dB (Master II), and 53 dB (FeCr). With A weighting, these figures improved to 59, 60.3, and 58 dB. Finally, with the Dolby system in use, and with CCIR/ARM weighting, the S/N was 65.6 dB with UD-XL I, 70 dB with Master II, and 67.4 dB with FeCr. The noise increased by 10.5 dB through the microphone input at maximum gain.

The meters responded accurately to peak signal levels, indicating 100% of the steady-state value on a 0.3-second tone burst and decaying relatively slowly. The meter calibrations were also highly accurate. (Many tape decks have meter errors of a decibel or more at some points, even near their maximum readings, but the C 819 meters were "on the nose.") Calibration of the Dolby level marks (at 0 dB) on the scale was accurate within 1 dB when playing standard Dolby-level tapes. Crosstalk from right to left

## Performance Specifications

Specification	Rating	Measured
Signal-to-noise, w/Dolby		
Ferric oxide	Over 64 dB	65.6 dB (CCIR/ARM)
Chromium dioxide	Over 64 dB	70 dB (CCIR/ARM)
Ferrichrome	Over 67 dB	67.4 dB (CCIR/ARM)
Crosstalk	Over 40 dB	54.5 dB (at 1000 Hz)
Wow and flutter (wrms)	Less than 0.05%	0.035% (JIS)
Harmonic distortion	Less than 0.7%	—
Speed accuracy	Less than $\pm 0.6\%$	—
Fast wind time (C-60)	65 s	60 s

channel at 1000 Hz was -54.5 dB (with a TDK AC-352 test tape.)

The tape transport yielded one of the lowest flutter measurements we have yet seen on a cassette deck (and, for that matter, on most open-reel decks). Using the TDK AC-342 flutter test tape, we measured the weighted peak flutter as  $\pm 0.06\%$  (CCIR). The wrms flutter (JIS) was only 0.035%. In a combined record/playback measurement, both figures increased by a mere 0.005%. The transport moved a C60 cassette from end to end in 60 seconds in fast forward, and 65 seconds in rewind. The headphone volume, with 200-ohm phones, was excellent.

**User Comment.** Many of the characteristics of the Dual Model C 819 invite the use of superlatives. In others, it ranks with some of the better cassette decks tested. We were most impressed with the C 819's low flutter and its foolproof level meters. (If the meters do not exceed 0 dB, one can be certain of a clean, undistorted, and uncompressed recording.) When we recorded FM tuner interstation hiss and compared playback to the origi-

nal, very little difference was found at the highest frequencies, where most cassette decks tend to sound "soft." There were audible differences at the low and middle frequencies, but on the whole the Model C 819 proved to be exceptionally accurate.

Usability of the MEMORY WIND feature in fast forward as well as in rewind is a convenient plus for this machine (most recorders with a similar feature can use it only during rewind). The FADE EDIT system worked perfectly, although it will probably be of interest only to a limited number of recordists. We must caution users of the Model C 819 that the FADE EDIT system functions on any cassette, even one whose recording interlock tabs have been removed.

We cannot conclude a review of the Dual Model C 819 without commenting on its unusually clean, uncluttered internal construction. Most circuits are on a single, large board on which are mounted several smaller boards. It presents a highly professional appearance when the top cover is removed, and our tests confirm that its performance fits that image.

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## Crown Model DL2 Digilogic Control Center can interface with 8080-based computer



To call the new Model DL2 Digilogic Control Center from Crown a stereo

preamplifier is like calling a perfect diamond a "hunk of carbon." The Model DL2 is actually a "system" that consists of the Digilogic Control Center, separate power-supply module,

and outboard phono preamplifier module. The system was designed to have the lowest possible noise and distortion. The rated A-weighted noise is -94 to -101 dB at maximum gain, referred to a 2.5-volt output. Distortion of any order is rated at much less than 0.001% at any usable output level.

uses separate  
phono-cartridge  
and power-supply  
modules





# **"Enormously Efficient."**

The computer-optimized Wharfedale E's. Beautifully designed and crafted. For the sophisticated connoisseur of sound.

Unusually efficient (94dB/W/m), the E's are clean and easy-to-listen-to, with notably good transient response. Distortion is inordinately—and inaudibly—low.

## **"Exceptionally flat..."**

Response is wide and flat (50-18,000Hz,  $\pm 3$ dB for the E-70), with exceptional bass performance.

That's why audio experts acclaim the E's. Why audiophiles adore them.

The Wharfedale E-70's and E-50's come in matched, hand-finished, walnut-veneer pairs. Audition the

E's and our complete line of high-quality loudspeakers at your Wharfedale dealer today.

We know you'll be enormously impressed.

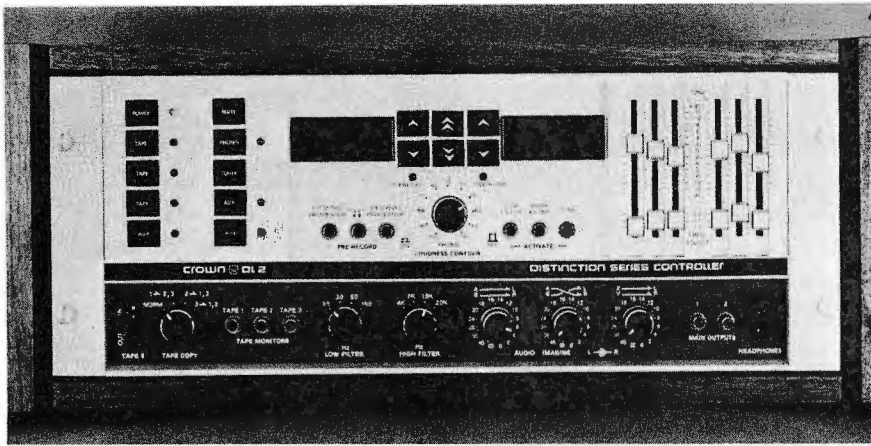


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The true novelty of the Model DL2 is in its basic design. The key operating functions are controlled by digital logic, which can be interfaced with an 8080-based computer. The Model DL2 has a connector for this purpose and is, in fact, routinely checked with such a computer at the factory. (A computer interface module and test and operating programs are planned for the future.)

The basic control center measures 17"W x 14"D x 7½"H (43.2 x 35.6 x 19 cm), while its companion power supply is 17" x 7½"D x 3½"H (43.2 x 19 x 8.9 cm). The respective weights are 20 and 9 lb (9 and 4 kg). Optional items include: 19" (48.3-cm) rack-mounting hardware, wooden cabinets, and a Phono Module A that measures 6½" x 3½" x 1¾" (16.8 x 8.9 x 3.5 cm) and weighs 12 oz (337 g). A similarly packaged Phono Module B for low-output moving-coil cartridges is soon to be available. Prices are \$1495 for the control center, \$250 for the power-supply module, and \$250 each for the phono modules.

**General Description.** The dominant visual feature of the Model DL2 is a pair of ¾" numeric displays, between which are six pushbutton switches. The displays indicate gain separately for each channel in 0.5-dB steps from 0.0 to 63.5 dB, while the buttons are for controlling the gain of the system. Two buttons vary the gain in both channels simultaneously and the others are for adjusting only one channel at a time in either direction. A momentary touch on a button steps the gain by 0.5 dB. Holding down the button causes the gain to change at an increasing rate to cover the full 63.5-dB range in only 3 seconds. Near the displays are OVERLOAD indicators that are set to flash at the rat-

ed 11-volt maximum input.

A large click-stop LOUDNESS CONTOUR control reduces the volume in 5-dB steps as it is rotated clockwise while simultaneously boosting the low-frequency response. The loudness contours are based on International Standards Organization curves that are considered to be more accurate than Fletcher-Munson curves.

Pushbutton switches to the left of the LOUDNESS CONTOUR control are for switching into and out of the signal

## noise and distortion are below measurement levels

path either or both of two EXTERNAL PROCESSOR accessories (equalizer, noise-reduction system, or dynamic-range modifier, for which separate inputs and outputs are provided so that none of the Model DL2's tape recording and monitoring flexibility is sacrificed). A third button is for inserting the selected processor(s) into the signal path *before* the signal goes out to the tape decks. Similar buttons to the right of the LOUDNESS CONTOUR control are for engaging and disengaging the filter and tone controls

The TONE control system consists of two groups of slide-type potentiometers, each of which has a ±15-dB range and is detented at 2- or 3-dB intervals. They control the bass, mid-range, and treble for the two channels independently. A three-position switch below each control permits the frequency of maximum effectiveness for the control to be shifted by one octave above and below a nominal value. The result is an extremely flexible tone-control system.

At the upper left of the control panel are the input-selector, POWER, and MUTE pushbutton switches, each with its own adjacent color status indicator. The preamplifier/control center can be turned off by touching the POWER button. Power is applied by touching any of the source-select buttons, assuming the power in the power-supply module is activated.

There are eight identical high-level program inputs. Three are labelled TAPE, three AUX, and one each PHONO and TUNER. All buttons can be labelled as desired. Any input used for phono must be preceded with a Phono Module (which goes near the record player to minimize cable problems in sensitive low-level circuits). As a rule, touching any source-select button automatically disengages the last selection.

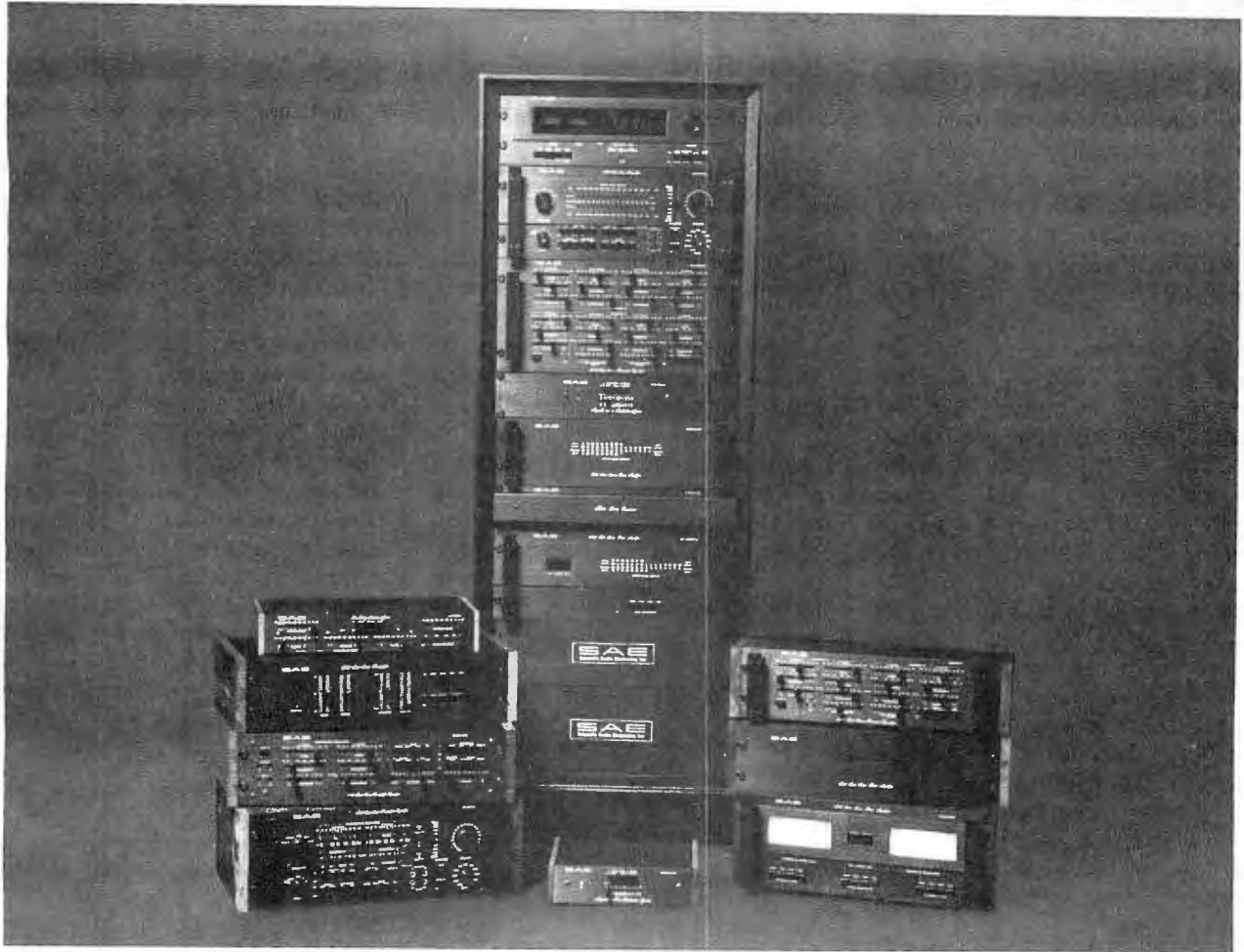
The remaining controls are arranged in a row across the bottom of the Model DL2's panel. At the left are the tape recorder controls, including a TAPE COPY switch that can be used to dub from any one of the three tape decks the control center can accommodate to one or both of the others or to record the selected program source on any or all three decks. Next come the TAPE 3 IN and OUT phone jacks that parallel connections on the Model DL2's rear apron.

Following the TAPE MONITOR jacks are two four-position controls for the cutoff frequencies of the LOW FILTER and HIGH FILTER systems, both of which have 18-dB/octave slopes. The low filter's cutoff frequencies are at 20, 30, 50, and 100 Hz, while the high filter's are at 4, 7, 12, and 20 kHz.

The next three controls are a unique feature of primary interest to serious recordists, although they can also be useful in a conventional home hi-fi system. Each of these AUDIO IMAGING controls is a concentric pair of 32-position switches that permit independent adjustment of the channels. Arrows above the knobs identify the corresponding input and output circuits. The first control channels the A and B inputs to the A and B outputs. It can be used to independently control the level for each channel. The next control is similar to the first, except that it transposes the routing. The third control is similar to the first, except that it controls an entirely different set of inputs on the rear apron (X and Y) and channels them to the A and B outputs, respectively.



# The Look & Sound of SAE



What you see here is the result of twelve years of devotion to the development and production of the most revolutionary and highest quality components in the audio industry. This is not the usual self-seeking statement by a biased manufacturer — to prove it, ask anyone who knows SAE.

But, it is not only uniqueness that sets SAE products so far apart from their competitors. It is a goal that SAE established long ago — a goal which states that it is manufacturing excellence as well as design that makes a product truly great.

The following points out the realization of this goal in our product.

## AMPLIFIERS

The complete line of SAE Stereo Power Amplifiers is the product of one heritage in both design and construction. The unique, fully complementary design system provides balanced amplification from input to output. This approach yields lower steady state and transient distortion as well as better overload recovery.

## PREAMPLIFIERS

A bold research and development program by our engineering staff has resulted in the introduction of the first integrated circuit (IC) designed specifically for audio applications. Extremely low distortion, low noise characteristics and fast overload recovery have made it ideally suited for preamp applications.

## PARAMETRIC EQUALIZERS

The parametric approach stands as a revolutionary advancement in equalizers for consumer products. The unique combination of controls provides for tonal modification never before thought possible.

## ASSOCIATED COMPONENTS

These components complement our line of amplifiers, preamps and equalizers. They include a digital readout FM tuner with linear phase IF filters and phase-lock multiplex; an Electronic Crossover for biamplication; an Impulse Noise Reduction System, the system that takes over where every other noise reduction system leaves off, by providing dramatic reduction of the impulse noises (clicks and pops) that occur in common playback of records; and our new Time Delay Ambience System, to recreate the live performance previously beyond reach in the home environment.

## CONCLUSION

As you can see, the goal of advanced design and manufacturing excellence has created the finest audio products in the world. With constant supervision of assembly and testing, SAE products offer performance, value and consistency — functional, state-of-the-art, and without question, Components for the Connoisseur.

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# SAE

**Scientific Audio Electronics, Inc.**  
P.O. Box 60271 Terminal Annex, Los Angeles, CA 90060

The remaining front-panel controls include two pushbutton switches for separately energizing two sets of main outputs. At the far right of the lower portion of the front panel is a pair of stereo headphone jacks that are always live, driven by a separate amplifier stage that can drive any impedance phones (not electrostatic types) to full listening levels.

The many input and output jacks, all clearly labelled, are located on the Model DL2's rear apron. Standard phono jacks are used for the inputs, but the outputs are through 1/4" phone jacks. In addition to the normal outputs, there is a pair of inverted-phase outputs for MAIN 2 and a MONO summed output for MAIN 1. A pair of buffered outputs is also provided, taken from a point just after the input selector and not affected by any controls but the LOW FILTER. High-reliability connectors are used for connection to the Power Module and computer or a projected wireless remote control system. These connectors can also be used to slave additional Model DL2s to a "master" Model DL2 to increase the system's input-channel capabilities. When so operated, the "master" level and input controls operate the "slaves" as well.

The Power Module has a momentary-contact POWER pushbutton switch and a LED power indicator. It controls the power to the entire system. On its rear apron are two unswitched and seven switched accessory ac receptacles. Three of the switched receptacles are heavy-duty three-contact types. There are also multicontact connectors for powering the Model DL2 control center and a Phono Module.

The Phono Module has a pair of phono-jack inputs at one end and a pair of 1/4" phone-jack outputs at the other end. Slide switches are provided for changing the input termination from 47,000 to 100,000 ohms and removing the RIAA equalization to permit the module to be used as a microphone preamplifier. Two screwdriver-adjustable controls allow the gain of the phono preamp to be varied separately for each channel.

**Laboratory Measurements.** All our noise and distortion measurements merely reflected the limitations of our test equipment, rather than the performance of the Model DL2. We operated the control center with

## outstanding tone and loudness-control versatility

standard IHF input and output terminations and gain settings. Output noise levels were well below our 100- $\mu$ V minimum measurement capability, which is better than 90 dB below the 2.5-volt rated output of the DL2.

At maximum sensitivity, the preamp required a 53-mV input to generate a reference 0.5-volt output, and the OVERLOAD indicators came on abruptly at 11 volts. At maximum gain, Phono Module A required a 1.7-mV input for a 0.5-volt output. (For our measurements, the Phono Module A's gain was set to the IHF standard of 40 dB at 1000 Hz.) The phono equaliza-

tion was within  $\pm 0.1$  dB of the RIAA characteristic from 30 to 15,000 Hz and within  $\pm 0.2$  dB from 20 to 20,000 hertz.

Measured through the inductance of a typical phono cartridge, there was no change in the phono response, although a high-inductance cartridge did produce a rise of almost 1 dB at 20,000 Hz. The input resistance was 46,000 or 93,000 ohms, depending on the Phono Module A's switch setting. The capacitance could not be measured with our instruments.

The frequency response of the Model DL2 itself was within  $\pm 0.1$  dB from 10 to 50,000 Hz. It was down 0.2 dB at 5 Hz and 0.5 dB at 90,000 Hz. The filter curves were excellent, with steep slopes that were roughly 10 to 15 dB/octave in the useful portions of their ranges. The Low filter's response was down about 1 dB at 20 Hz. The -3-dB response frequencies of the other settings were 37, 43, and

## Performance Specifications

Specification	Rating	Measured
Frequency response (10,000 ohm load)	$\pm 0.1$ dB 10-50,000 Hz	Confirmed
Hum & noise (inputs shorted, 20-20,000 Hz, below rated output 2.5 V)	Max. gain: 101 dB (A-wtd) Unity gain: 107 dB. "	Better than 90 dB down
IM distortion (SMPTE)	Less than 0.0003% at 10 volts or less	0.002% (instrument residual)
THD (20-20,000 Hz): 2.5 V	Less than 0.0008%	Less than 0.01% (instrument residual)
	10 V Less than 0.0025%	
Maximum gain	20 dB $\pm 0.2$ dB (100,000 ohms)	Confirmed
Output	11 V maximum 2.5 V rated (50 ohm)	Confirmed
Headphone output	17 V rms (1 ohm source)	—
Gain tracking	$\pm 0.2$ dB over 63.5-dB range	—
Audio imaging	50-dB range, tracking within 0.2 dB	—
Muting	5-7-s turn-on delay	
<b>Phono Module A</b>		
Frequency response	$\pm 0.25$ dB of RIAA, 20-20,000 Hz	$\pm 0.2$ dB
Hum & noise (shorted) below 10-mV input	94 dB (A-wtd)	Less than 90 dB
IMD (as MIC amp)	Less than 0.0005% at 2.5 V	—
THD	Less than 0.002% at 2.5 V	—
Gain	Adjustable 30 to 50 dB	Confirmed
Input impedance	47,000/100,000 ohms less than 5 pF	46,000/93,000 ohms Not measured
Input overload	33-330 mV depending on gain	
	100 mV at 40-dB gain	95 mV
Output voltage	11 V (600 ohms) into 10,000-ohm load	—





*The complete control system, as shown here, includes the control center, power-supply module and separate modules for each phono cartridge input.*

140 Hz. The HIGH filter's response was down 3 dB at 4100, 4400, 13,000, and 15,000 Hz.

The tone controls were capable of producing a nearly infinite variety of response curves. We noted that the shape of the curves changed when we switched the frequencies to the X0.5 and X2 conditions. Lower frequencies appeared to have lower Q, which gave a broader response peak or dip at the extreme control settings. Of course, it is of little importance to the user, who will presumably adjust the controls to obtain a desired sound quality.

The LOUDNESS CONTOUR system had its principal compensation effect below 100 Hz. It was free of the unnatural heaviness that mars the sound of most loudness-compensation systems in current use.

**User Comment.** We judged the Model DL2 solely on its performance as a home hi-fi system control center, under strictly manual control of all its functions. Everything—electronic and mechanical—operated flawlessly. We feel, however, that some of the system's features are not of great import in a home music system. The gain display is intriguing, for example, but its usefulness is diluted by the fact that overall gain is also affected by the AUDIO IMAGING and LOUDNESS CONTOUR controls, whose effects do not show up on the displays.

Tape recording enthusiasts will doubtlessly like the AUDIO IMAGING controls. Others might find that it's less convenient to use for channel

reversal and blending than the conventional switch controls.

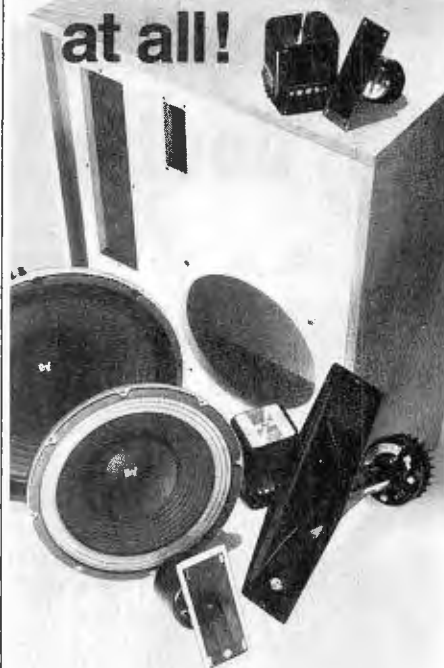
The overall tape-recording facilities of the Model DL2 are second to none. Too, the filters, tone controls, and loudness compensation were outstanding. The digital gain-stepping feature is fun to use and, with practice, can be manipulated almost as easily as a standard volume-control knob.

We were puzzled to find only one power socket on the control center's rear apron for a Phono Module. Many serious audiophiles have more than one record player, and it is expected that a deluxe preamplifier such as Crown's would accept more than one phono input. Indeed, Crown points out that all eight of the Model DL2's inputs can be used for phono sources if a Phono Module is added for each. Presumably, Crown plans to have some sort of power socket accessory to permit hookup of more than one Phono Module.

We cannot resolve in our minds whether this product was meant for the home-audio or professional-audio market. It is far too costly and versatile for all but a small percentage of home users. Yet, its home-decor appearance would not be entirely in keeping with strictly professional equipment. On the other hand, whatever one's needs may be,—computer control, staggering control versatility, and the highest possible electrical performance, among them—the Model DL2 Digilogic Control Center is certainly the answer to the need.

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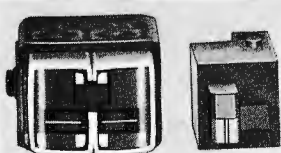
Why 3 heads are better than 2.

Why 2 capstans are better than 1.

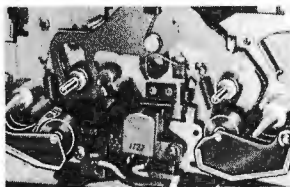
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# BUILD A COMPUTER-vs-YOU CHESS GAME

Popular Electronics®

DECEMBER 1978

*Microprocessor-based chess game features three player levels and a unique system of switches under board squares to simplify data input of piece moves*

BY BILL GREEN

With the development of microprocessors and their dramatically reduced prices over the years, it is not surprising that the delightful and intriguing game of chess became widely available for computer play. A natural follow-up to chess-game software for microcomputers were dedicated-chip chess games, including "Chess Challenger," "Boris," and "CompuChess," among others. The "Computer Chess" game project presented here is a similar type of game that features some outstanding advantages: moderate cost (\$100), battery-power capability for portability, and simplified computer data entry system.

(A pressure-switch system under each board square operates like a calculator-type keypad.)

The Computer Chess project is built around a Signetics 2650 microprocessor chip and 2 kilobytes of memory. The chess program is resident in a programmed ROM, and there are three selectable levels of skill.

Your moves are entered by pressing a chesspiece on a conventional playing "board" made up of 64 pressure-sensitive switches, one for each square on a conventional board. Commands, player moves, and computer moves appear in a two-digit seven-segment LED display.

It can operate on line power only or both line and battery power.

**Software.** The software used for the Computer Chess game is a modified form of the Claude Shannon algorithm, published in 1950 as the first practical paper on computer chess. The program is written in three sections, which include entry for command and move, move generation, and move evaluation.

In the entry mode, the playing board can be set up in a standard manner, or each piece can be entered in a special manner to play portions of games (such as mate in two moves, ends of games,



etc.). In the move-generation mode, each piece on the board is moved to all possible legal squares, while the move-evaluation mode calculates the result of each iteration through the possible moves and selects the move with the highest value for entry and display. The computer's opening moves are random.

**Hardware.** The complete circuit of the Computer Chess game is shown in Figs. 1 through 4. The system's 2650 central-processing-unit (CPU) IC1 performs all chess operations. Its operating program is stored in read-only memory IC2. The playing board and other variables are stored in the random-access-memory

## PARTS LIST

B1 thru B4—Four 1.5-volt C cells in series (rechargeable Ni-Cd cells optional)  
C1—1000-pF disc  
C2—20- $\mu$ F, 6-volt tantalum electrolytic  
DIS1, DIS2—TIL312 (TI) or similar red seven-segment display  
IC1—2650 central-processing-unit (Signetics)  
IC2—91341 custom-programmed ROM  
IC3, IC4—2112 random-access-memory  
IC5, IC6—74LS373 octal-latch  
IC7—74LS244 octal noninverting tristate buffer  
IC8—74LS00 quad 2-input low-power Schottky gate  
IC9, IC13—74LS20 dual 4-input low-power Schottky gate  
IC10—74LS14 hex low-power Schottky Schmitt trigger  
IC11—74LS30 8-input low-power Schottky NAND-gate  
IC12—7404 hex-inverter  
All resistors  $\frac{1}{4}$ -watt, 10% tolerance:  
R1—1000 ohms  
R2, R3—47 ohms  
R4—220 ohms  
R5 thru R13—10,000 ohms  
S1—Normally open spst pushbutton switch

S2—Spst switch

Misc.—Suitable enclosure; printed-circuit boards; IC sockets for IC1 thru IC4; conductive elastomer; Mylar or acetate film; white contact paper; battery holder; red acrylic filter for display; 16-conductor flat ribbon cable; insulated stranded and solid hookup wire; bare wire; machine hardware; solder; etc.

Note: The following items are available from Alpha Electronics, P.O. Box 1005, Merritt Island, FL 32952 (Tel: 305-453-3534): Complete kit, including case but not chess pieces, batteries, battery holder, IC sockets charger, and charger jack, for \$100 (\$110 after March 1, 1979) plus \$4.50 postage and handling. (Canada \$6, others \$10). Case supplied with kit includes unfinished wood frame, cut, grooved, and drilled. Keyboard legend is silk-screened with board layout and labelled with numbers and commands. Punched separator and elastomer are supplied. Also available separately are: Both pc boards (Part No. Chess PC) for \$25 ppd; ROM (Part No. 91341) for \$50 ppd in U.S. (add \$2 for Canada, \$6 for other foreign orders). Florida residents, add 4% tax.

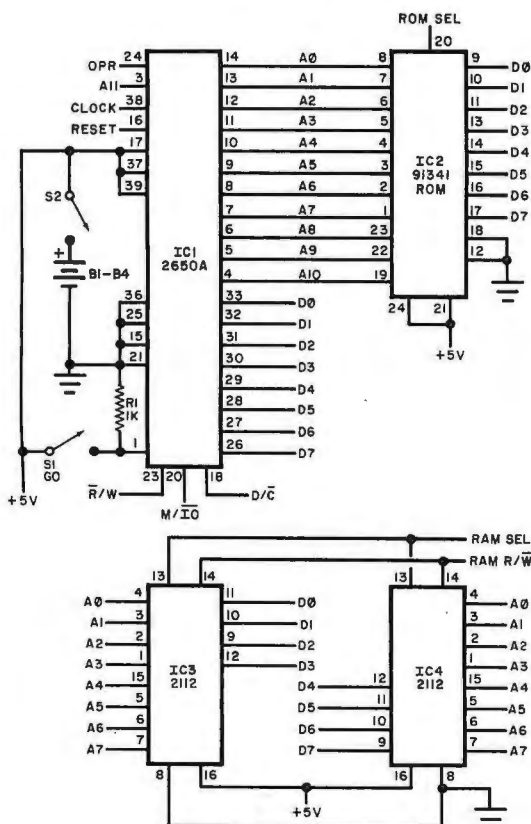


Fig. 1. The program for the CPU (IC1) is contained in ROM IC2. Program variables are stored in RAM IC3 and IC4.

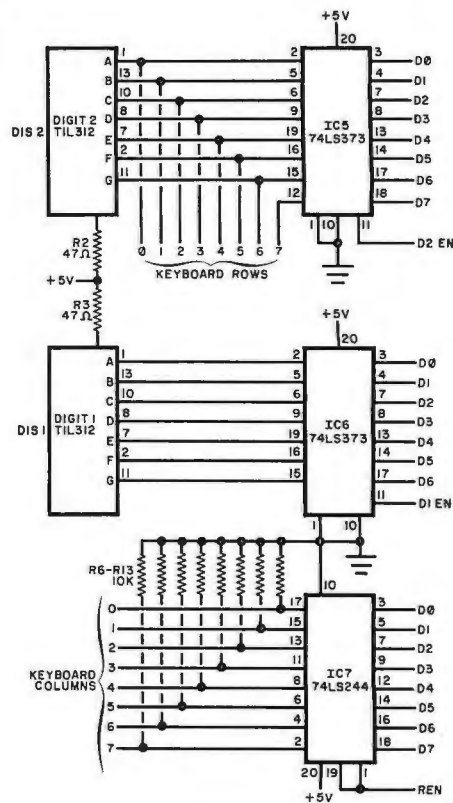


Fig. 2. Data bus latches IC5 and IC6 drive DIS1 and DIS2. IC5 also provides row key scanning. IC7 reads keyboard columns.

system made up of IC3 and IC4, as shown in Fig. 1.

Data on the data bus is latched by IC5 and IC6 (Fig. 2) for display on seven-segment displays DIS1 and DIS2. In addition, IC5 provides a scanned output to the keyboard rows, while IC7 reads data in from the keyboard columns. Integrated circuits IC8 through IC13 shown in Figs. 3 and 4 provide decoding for the memory select and the read/write select for the RAM. A part of IC10 (Fig. 3) is used to generate the power-up reset for the CPU, and a part of IC12 (Fig. 4) generates the system's clock.

With the exception of the memory, CPU and IC12, all ICs in the Computer Chess circuit are low-power devices. Hence the average current drain of the system is about 300 mA.

**Construction.** The Computer Chess game's circuit is best assembled on two printed-circuit boards. The etching/drilling and components placement guides for the main pc board, which is double-sided with plated-through holes, are shown in Fig. 5. The circuit board for the keyboard is a simple single-sided one as shown in Fig. 6.



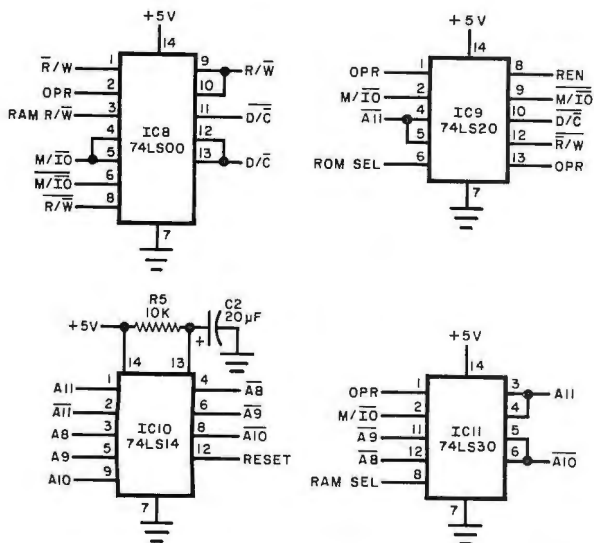
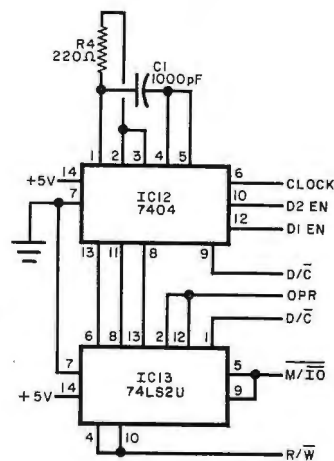


Fig. 3. These IC units provide proper decoding signals for the RAM. Part of IC10 generates system power-up reset.

Fig. 4. Some decoding signals are generated here while part of IC12 is used as the system clock.



Install the eight jumpers on the blank side of the circuit board for the keyboard from end to end, as shown. Use fine bare wire to make the three inside jumpers, for a total of five solder connections per jumper. A minimum amount of solder should be used to make these connections; trim away the excess wire as close as possible to the board. Place a small piece of electrical tape over each solder connection on the foil side.

Connect and solder a 12" (30.5-cm) length of 16-conductor flat ribbon cable (or 16 lengths of insulated hookup wire) to the solder pads on the left side of the keyboard assembly. Feed each conductor to its pad via the blank side of the board.

Divide a 7" × 7" (17.8 × 17.8 cm) sheet of 0.005" (0.13-mm) Mylar or acetate into a grid consisting of 64 (eight horizontal and eight vertical) equal-size squares. Cut a 1/2" (12.7-mm) hole in the center of each square.

Use a 7" × 7" sheet of 0.025" (0.66-mm) conductive elastomer for the common in the keyboard assembly.

Next, lay out an 8 × 8 square chessboard on a 7" × 7" sheet of white contact paper, making each square 3/4" × 3/4" (19.1 × 19.1 mm). Starting with the lower left square, paint each alternate square with red paint. When the paint is completely dry, label each square. Starting at the upper left square and moving to the right, label the squares from 00 to 07. The next row down is labelled from 10 to 17 and so on until the last row is labelled 70 to 77. Computer commands are labelled on the squares as follows: square 40—S, E, and 1; square 44—F and 2; square 42—D and 3; and square 43—L.

Place the Mylar separator sheet over

the board, positioning it so that the holes are centered over the foil contacts. Over this, place the elastomer and then the contact paper, the latter with square 00 at the upper left. Then cover the contact paper with a sheet of matte-finished Mylar and temporarily set the keyboard assembly aside.

On the component side of the main pc board, install suitable sockets at each IC location. Sockets are optional but highly recommended for MOS devices IC1 through IC4.

Install the resistors and capacitors in their respective locations on the board. be sure when you install C2 that you observe the proper polarity.

Connect lengths of black- and red-insulated stranded hookup wire to the – and + pads, respectively. Connect two 3" (7.6-cm) lengths of insulated wire to the pads for S1, located near pin 1 of IC1. Connect and solder the free ends of these wires to S1.

Insert the 16 wires from the keyboard into their respective pads on the main circuit board assembly and solder them into place.

Connect the free end of the red stranded wire to S2. Then connect another length of red stranded wire between S2 and the positive (+) end of the battery holder. If nickel-cadmium cells are used, select an appropriate charger and mount the charging connector. (The battery consists of four C-size cells in series.)

When installing ICs, observe the usual handling procedures for MOS devices (IC1, IC2, IC3, and IC4). Make certain that pin 1 of each IC is aligned with the 1 on the pc board.

Place the keyboard on a flat surface and turn on the power. An A8 should ap-

pear in the display. Then press S on square 40; an S should replace the 8 in digit 1 of the display. (Standard seven-segment displays are used for DIS1 and DIS2, so the S will look like a 5.) Press L on square 43; AL should now appear in the display. Now press 1, 2, or 3 (40, 41, or 42 respectively) to select the level of play; the display should read A1, A2, or A3. Finally press S1 and hold it until the A in digit 2 of the display turns to an 8. Release S1. The board is now set up for playing in the normal manner.

Here's an example of what might transpire as a player and the computer develop their pieces, and it will serve as a final check of your completed project. Press the chesspiece located on square 63 (queen's pawn, white); the display should read 63. After a momentary pause, the 6 should change to an 8. The display should thus read 83. When this occurs, move the pawn two squares to square 43 and press down; the display should now read 43. Briefly press S1. The display should blank and then flash random characters until the computer has made its move. The computer's move is displayed with the "from" and "to" square numbers alternately flashing. You then follow the computer's decision by physically moving the selected piece on the "from" square to the "to" square, without pressing down on the chesspiece.

Note that when playing levels 2 or 3, several seconds may elapse before the display blanks after pressing and releasing S1. The random-character flashes will also continue for a greater period of time than on level 1 before the computer displays its move. Naturally, the highest level (3) takes the longest time.

After the computer has displayed its

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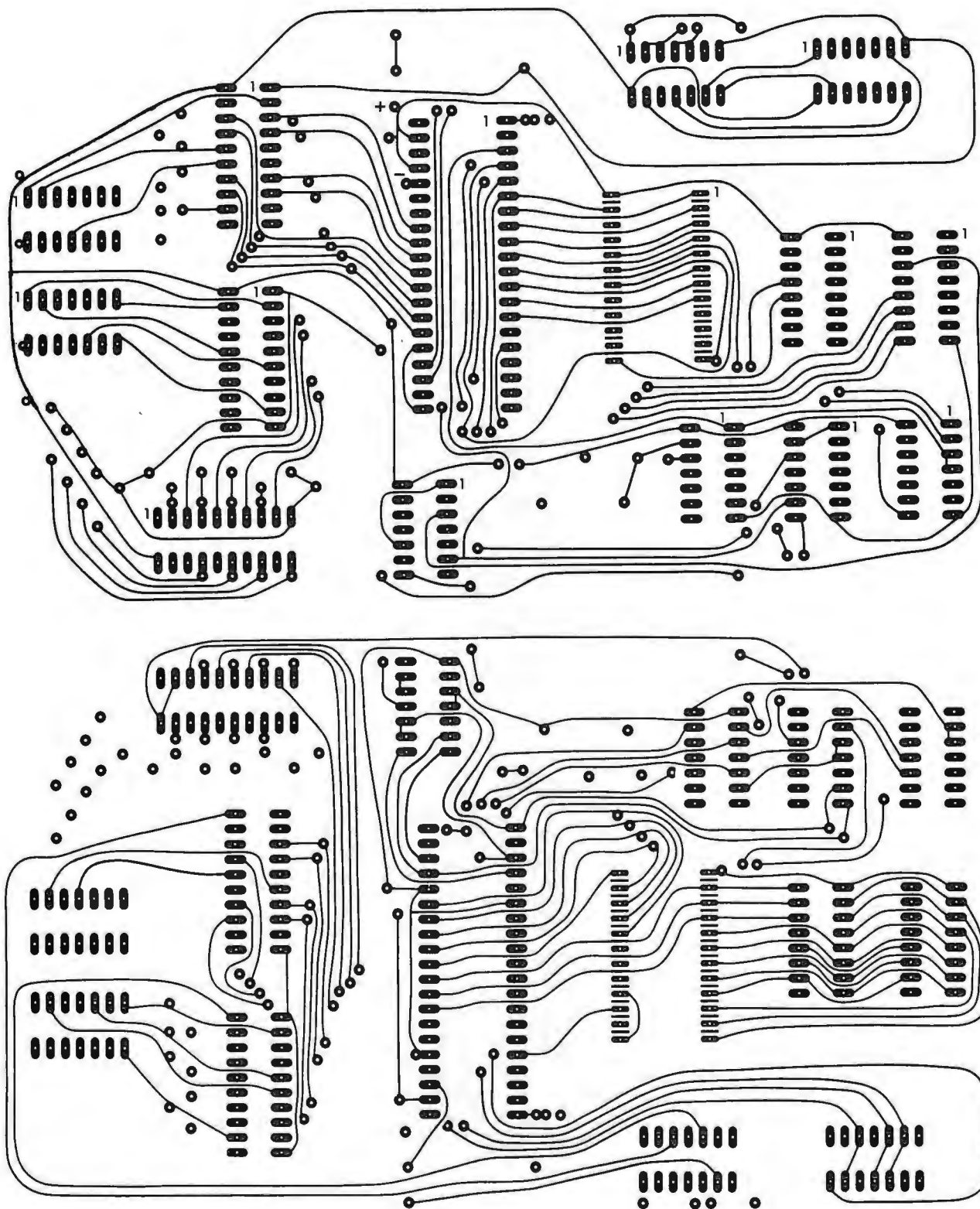
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move, press and hold S1 until an 8 appears in digit 2. This turns the upcoming board move back to you. You can then enter your new move, and continue the game as previously described.

**Operation.** The computer portion of the Computer Chess game has certain commands built into it. They're accessed as follows. Command "S" on

square 40 operates only after power up; it sets up the board for standard play.

Command "L" on square 43 lets you set the level of play. Pressing this square causes an "L" to appear in digit 1, as previously described. The desired level of play can then be selected by pressing the appropriate square. Level 1 on square 40 is for beginners and for one to develop a game quickly. Level 2

on square 41 is for intermediate play and may take between 10 seconds and more than a minute for the computer to come back with its move. Level 3 on square 42 is for more advanced players. Here, the computer's move may take as long as several minutes if the board is complex.

Pressing Command "E" on square 40 permits a player to enter a piece should



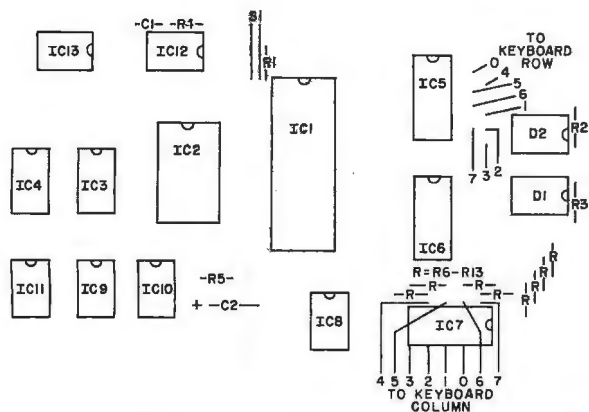


Fig. 5. Actual size etching and drilling guides for main pc board, which is double-sided, are on opposite page. Component placement is at left.

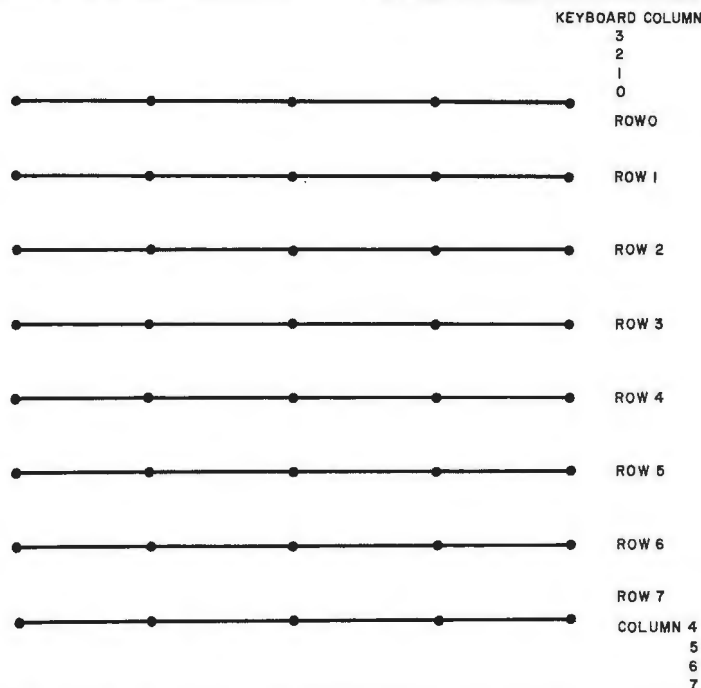
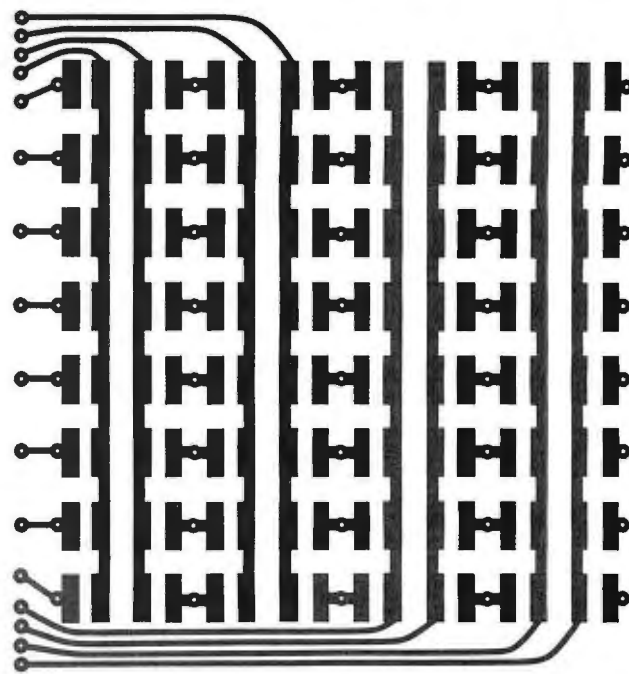


Fig. 6. Foil pattern for the keyboard pc board is shown below half-size. Below-left are connecting wires which must be added.



one wish to do so. This causes an "E" to appear in digit 1. Once the "E" appears, you press the square on which the piece you wish to enter would be in a standard setup and then press the square on which you wish to place the piece. The selected piece is displayed in the same format as in the find-piece mode, which follows.

Command "F" on square 41 finds a piece in the event you wish to check the accuracy of a piece's earlier placement on a square. You press this square until an "F" appears in digit 1 and then press the square you wish to examine. The piece on the latter square will be identified in the display. If the piece is black, a lower-case "b" appears in digit 1, as an example. If white, nothing will appear. (A complete list of the special symbols in the Computer Chess game is given in the Chesspiece Identification Table.)

Pressing Command "D" on square 42 enables you to delete a piece. Press this square and a lower-case "d" appears in

digit 1. Press the square for the piece you wish to delete, and the type of chesspiece and its color are displayed.

A variety of changes can also be made during play. These include changing the level of skill, deletion of a piece, entering a piece, finding a piece. To perform any of these changes once pieces have been developed, you must interrupt play and enter the command mode. There are two ways to enter this mode. If the computer's move is flashing, briefly press S1 when the "to" square number is displayed. (If the display is flashing 14 to 34, press S1 briefly when 34 appears.) If this is done properly, an A should appear in digit 2, which indicates that the computer is in the command mode. Now you can make your change, following which, you press and hold S1 until an 8 appears in the display. You can now resume play.

The second way of entering the command mode is on your own move, either when an 8 is displayed or by pressing

S1 until an 8 appears to avoid the trickier first method. Now you must make a false move from and to any two empty squares and then press S1. This will cause a lower-case "u" to appear in both digits of the display, after which the second digit will automatically change to an "A." Thus, "Au" will be shown in the display. (Each "u" is made up of segments b, f, and g in the display.) This places the computer in the command mode. Again, after making your change, press and hold S1 to obtain an 8 in the display, and resume play.

If you enter a move from an unoccupied square the display will flash "uu" after you press S1. Digit two will then display an "A." You can now use the command keys to locate, enter, or delete a piece or change the level of play. Press S1 until an 8 appears in digit two and reenter your move. If you should make a move and want to change it, press and hold S1 until an 8 appears in digit 2 and reenter your move.

If power is switched off to clear for a new game, wait about five seconds before switching the power back on to allow the reset capacitor to discharge.

The computer will castle whenever it can do so legally if there is no better move available. It moves the rook internally but does not, however, display the move. Instead, it indicates the king's move in the display.

You can castle in two steps. To do so, when it is your turn to move, enter the command mode and delete the rook you wish to use. Then reenter the rook on its new square. Press S1 to obtain an 8 in the display. Then move the king in the normal fashion, as your move. Bear in mind that the computer will accept an illegal move on your part but will not itself make an illegal move. If the computer places you in check, "--" will appear in the display between the "from" and "to" square displays. If you checkmate the computer, the

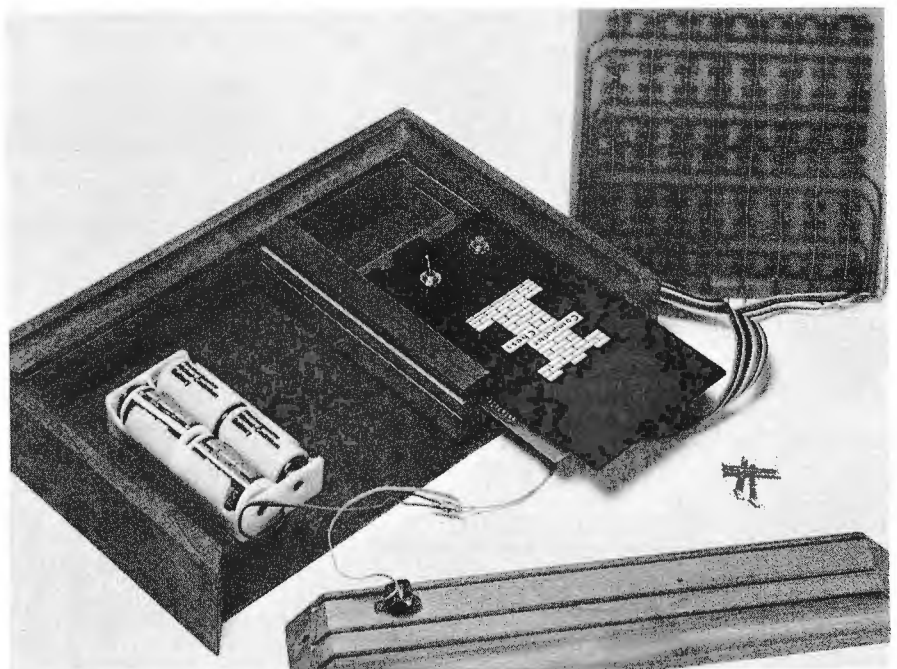


Fig. 7. Photo shows prototype unit disassembled. Keyboard fits in grooves over batteries. Battery charger plug is in rear panel.

## CHESSPIECE IDENTIFICATION TABLE

	KING
	QUEEN
	BISHOP/BLACK
	KNIGHT
	ROOK
	PAWN
	INDICATES COMMAND MODE
	LEVEL SELECT MODE
	YOU ARE IN CHECK (APPEARS BETWEEN FROM AND TO)
	NO PIECE ON SQUARE SELECTED
	STANDARD FORMAT
	ENTRY MODE
	FIND MODE
	DELETE MODE
	INDICATES COMPUTER IS READY FOR YOUR NEXT MOVE

display will give you the number of moves made in the game.

If you are able to promote one of your pawns, you must delete it from the board and reenter the new piece before moving it to the last rank. You can select the highest piece captured by the computer but not higher. (You cannot have more than one queen, two rooks, two knights, and two bishops on the board at any one time. If you select a captured bishop, make sure that it is the correct one for the color of the square onto which it is to be placed.)

The desired piece is entered on the square from which the pawn was deleted in the following manner. Press first the square on which the piece to which the pawn is to be promoted was located at the beginning of the game and then the square from which the pawn was deleted. (This will not affect a piece on the square first pressed when the game is resumed.) The symbol of the piece (see table of piece symbols at left) to which the pawn is to be promoted will appear in the display.

If the computer moves one of its pawns into your back rank, and its queen has been captured, it will automatically promote the pawn to a queen. If its queen has *not been* captured, you must promote the pawn to its (computer's) next highest available piece, in the same manner as promoting your own piece.

The Computer Chess game does not automatically perform the rarely used *en passant*. To perform such a pawn capture, you must enter the command mode and make the proper moves.

**Final Assembly.** After checking out the system, mount it in an enclosure like that shown in Fig. 7. The electronics pc assembly can be covered by a 1/8" (3.2-mm) sheet of red acrylic plastic to allow the red seven-segment LED display to be seen. Switches S2 (power) and S1 (go) also mount on this acrylic panel. Secure the battery holder to the bottom plate under the keyboard assembly. Then drill a hole in the rear panel to accept the selected battery charger's plug, and mount its jack at this location.

Check the nickel-cadmium cells (C or sub-C size) you plan to use to determine their maximum charging rate. Just about any wall-type calculator charger capable of delivering 6 to 12 volts dc can be used. Measure the output voltage from the charger and, using the maximum charge rate for the NiCd cells, calculate the value of the required resistor. You can determine the resistor's value by dividing the measured output voltage from the charger (minus about 10% to be on the safe side) by the maximum charge-rate current specified on the cells.

If you prefer to have the Computer Chess game powered from the ac line only, simply substitute a well-regulated 5-volt dc supply capable of delivering a minimum of 100 mA.

**In Conclusion.** The Computer Chess game is an excellent chess-learning tool for the beginner and a challenge for those who already know how to play chess but need an opponent. ◇



**A**M-BROADCAST stations are about to undergo a massive change. During the summer of 1979, assuming the FCC comes to a final decision by then, many AM stations in your area will begin broadcasting in stereo.

AM stereo is not new. In 1925, WPAY (New Haven, CT) made the first wireless stereo transmissions by broadcasting from two separate AM transmitters on two different frequencies. In the mid-1950s, a small number of stations expressed renewed interest in AM stereo by experimenting with AM and FM simulcasting. Historically, then, two separate receivers were needed to obtain stereo audio. With the new systems proposed to the FCC and detailed here, a single AM-stereo transmitter and a single AM-stereo receiver are needed. The transmitted AM-stereo signal is also mono-compatible.

**The Contenders.** There are five AM-stereo system designs presently before the FCC, proposed by Belar Laboratories, Harris Corp., Kahn Communications, Magnavox, and Motorola. Each system has its own unique method for generating stereo signals.

The *Belar* system amplitude modulates the carrier with  $L + R$  information and frequency modulates the carrier with  $L - R$  information, using 320-Hz frequency deviation and 400- $\mu$ s preemphasis. The *Harris* system employs quadrature modulation with a reduced  $L - R$  component, which is equivalent to  $L$  and  $R$  modulation of two carriers separated in phase by  $30^\circ$ . The *Kahn* system uses independent-sideband (ISB) modulation to force the modulated envelope to carry  $L$  and  $R$  information. *Magnavox's* system utilizes simple  $L + R$  amplitude modulation with  $L - R$  phase modulation of the carrier with  $57^\circ$  phase deviation. Finally, *Motorola's* system, like the *Harris* system, employs quadrature modulation, but it predistorts the entire signal, not just the  $L + R$  sidebands, to force the modulated envelope to carry the  $L + R$  information.

Each of the proposed AM-stereo systems is compatible with the mono receivers currently in use. Compatibility with present-day mono envelope detectors and good stereo performance have been the major hurdle for the proponents of AM stereo. The challenge has been met with some success.

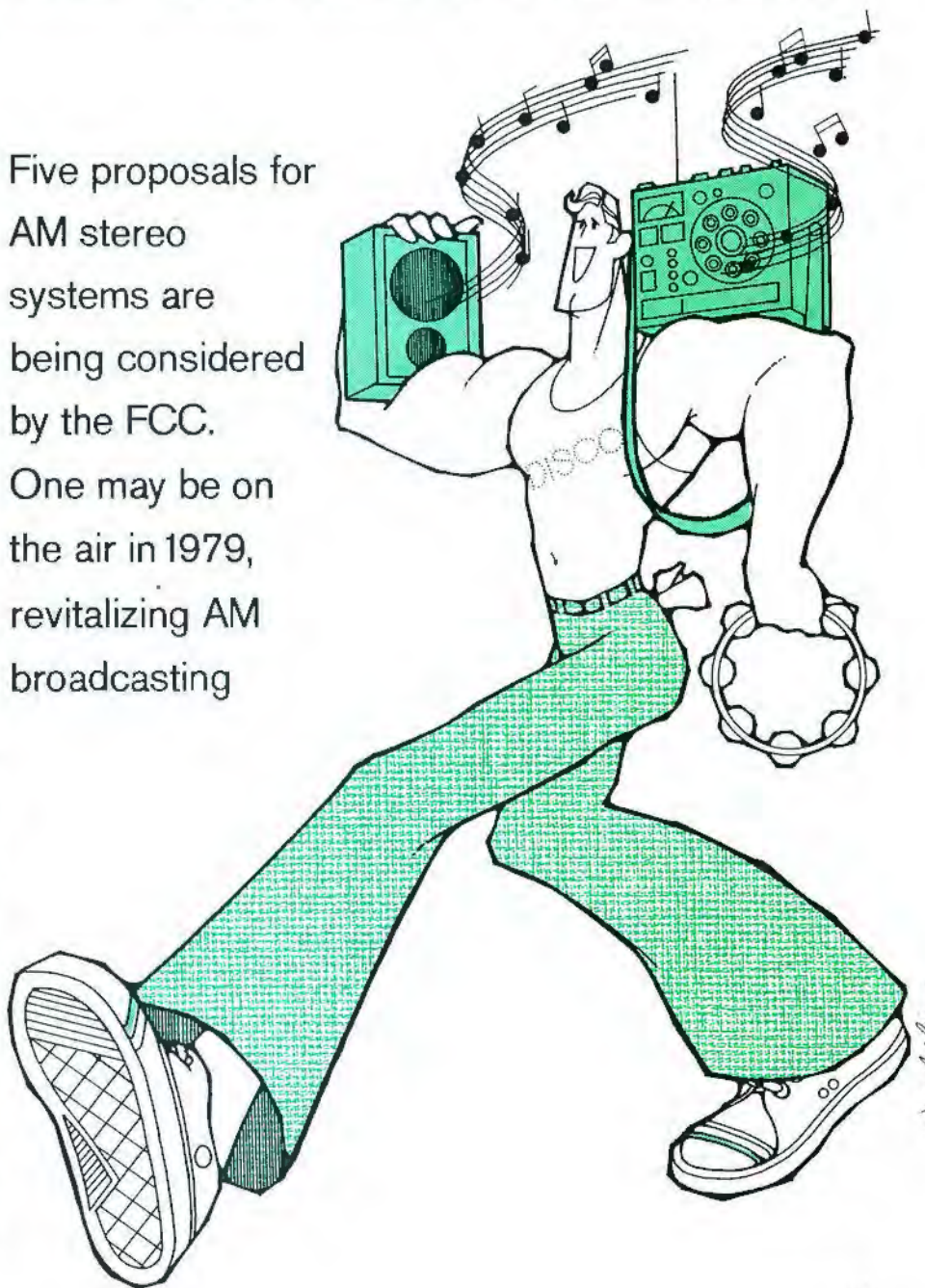
Some common features and methods appear in each of the proposed AM-stereo systems. All process the audio

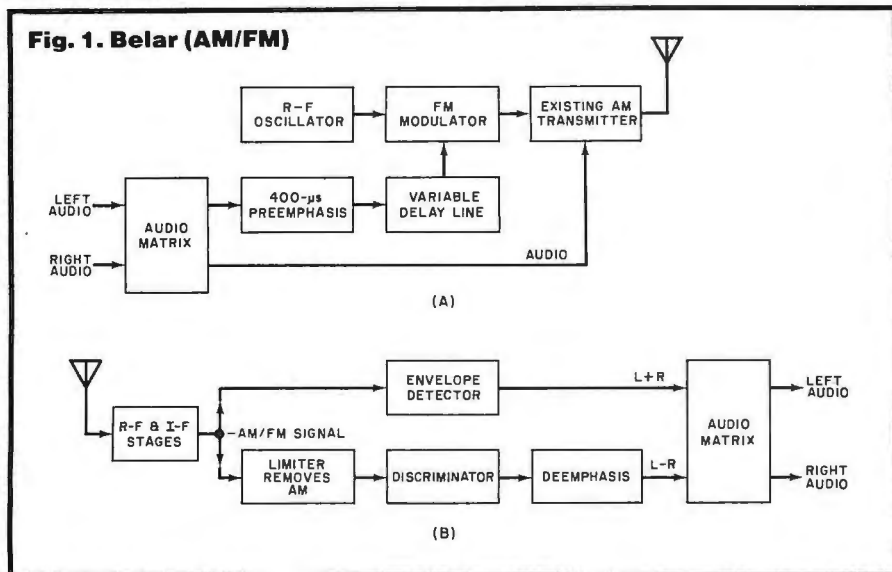
BY JOE DEANGELO

# AM STEREO

## SOON ON THE AIR?

Five proposals for AM stereo systems are being considered by the FCC. One may be on the air in 1979, revitalizing AM broadcasting



**Fig. 1. Belar (AM/FM)**

systems. Now let us look at the individual systems in brief detail.

**Belar (AM/FM).** This system uses AM/FM techniques for modulation. The L + R audio component is applied to the modulator stage of the transmitter and amplitude modulates an FM carrier (Fig. 1A). This allows current mono receivers to detect L + R audio and makes the Belar system mono-compatible.

To generate the stereo part of the signal, the L - R information from an audio matrix is applied to a 400-μs preemphasis network and a time-delay network that, in turn, frequency modulates the carrier. Peak deviation of the carrier is  $\pm 320$  Hz. The FM carrier is then amplitude modulated.

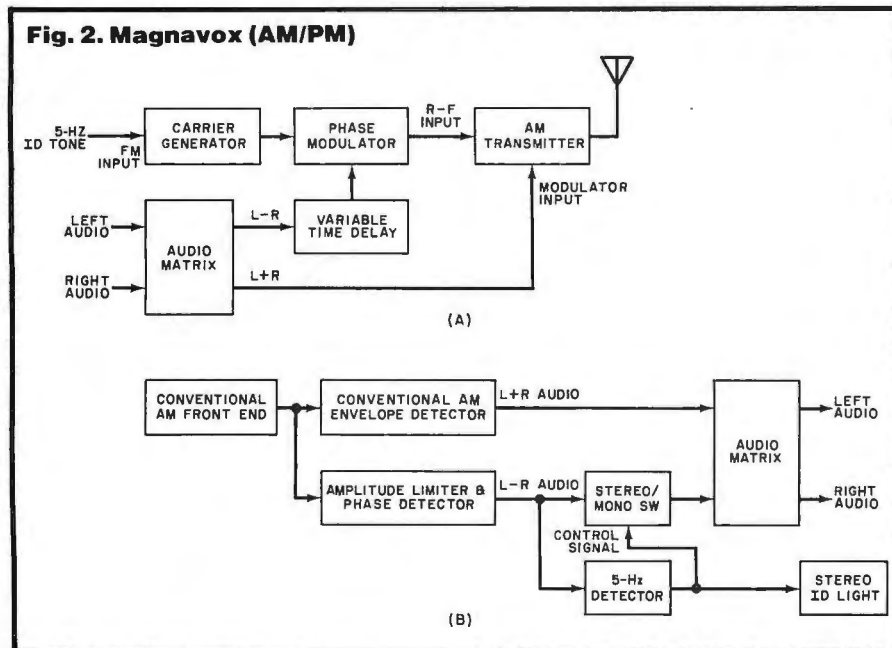
Reception of the Belar signal is perhaps the easiest for the five systems. The i-f output of the receiver (Fig. 1B) is split into two paths. One path goes to an envelope detector that recovers L + R information and the other goes to a hard limiter that strips away all AM components. The limited i-f signal then passes through a frequency discriminator that recovers L - R information. The L - R audio must then be deemphasized to cancel out the preemphasis applied at the transmitter. The detected L + R and L - R audio components are then applied to an audio matrix, where discrete left- and right-channel signals are obtained.

**Magnavox (AM/PM).** Somewhat similar to that of Belar, in this system, the L + R information amplitude modulates the carrier and the L - R information phase modulates the carrier (Fig. 2A). The phase variation of the carrier is held to a peak of  $57^\circ$ . The FM carrier is then amplitude modulated.

Reception of the AM/PM signal is illustrated in Fig. 2B. The i-f signal is split into two paths, one of which goes to an envelope detector to recover the L + R information and the other goes to a limiter to eliminate AM components. A phase detector is then used to recover the L - R audio. The recovered L + R and L - R signals are combined in an audio matrix to yield independent left- and right-channel stereo signals.

**Kahn (ISB).** In this independent-sideband (ISB) modulation system, the left-channel information appears on the lower sideband and the right-channel information appears on the upper sideband. This system predistorts the entire signal to force the envelope to carry L + R signals for mono compatibility.

As shown in Fig. 3A, the left and right audio channels are applied to a matrix.

**Fig. 2. Magnavox (AM/PM)**

through a matrix for transmission and reception. Each system's stereo generator (similar to those used in FM) combines the two audio channels to give L + R and also subtracts them to obtain L - R signals. The stereo information is transmitted as L + R and L - R information. The AM-stereo receivers then demodulate the carrier and derive the L + R and L - R signals. Once again, the signals are passed through an audio matrix to obtain independent left- and right-channel signals.

Except for the Belar system, all of the proposed AM-stereo systems incorporate a low-frequency stereo-identification tone. The frequency of the tone varies from system to system. Magnavox uses a 5-Hz tone, while the other systems' tones are in the range of 15 to 25 Hz. The tone is placed on the L - R

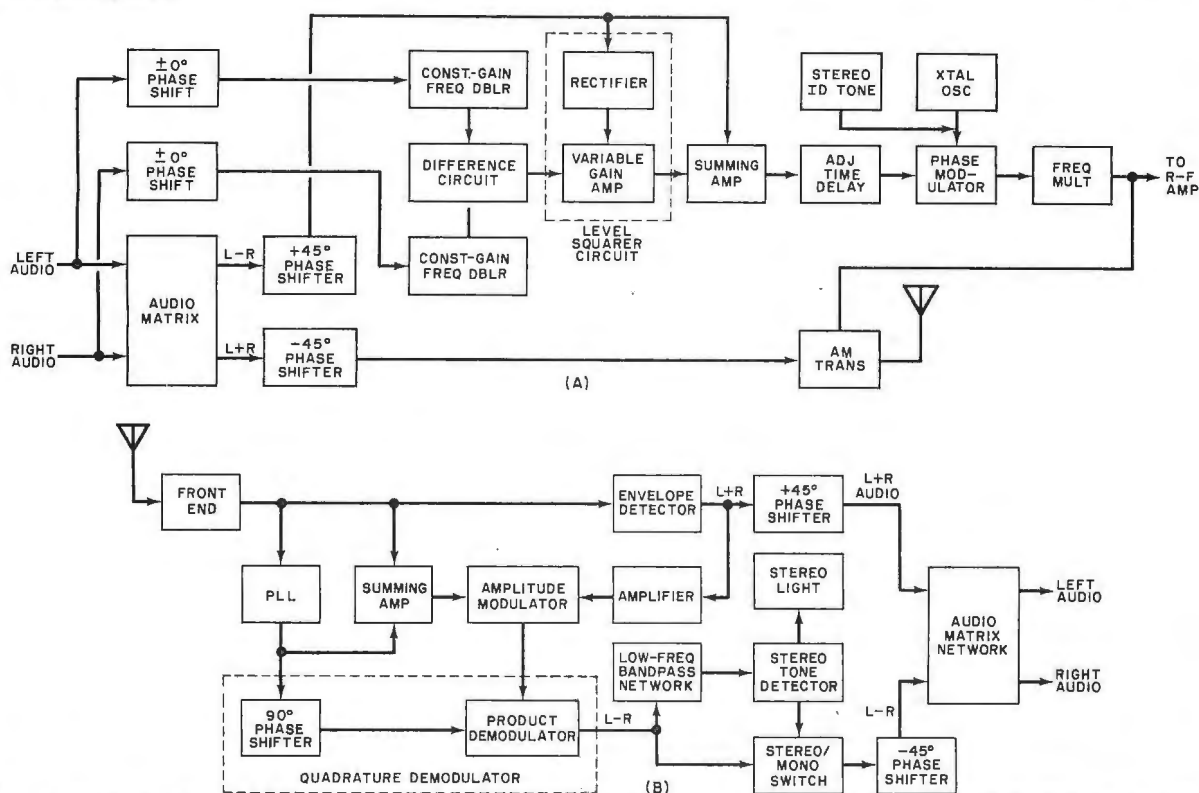
channel signal and is designed to turn on a stereo indicator in the receiver and possibly to activate an automatic stereo/mono switching system. The ID tone could also be used to carry low-speed digital data, such as station identifications, which could appear on a numeric display in the receiver.

To preserve audio separation, each system employs time-delay networks in the L + R or/and L - R paths. A finite time delay exists between the r-f section and the modulator section of a standard broadcast transmitter. A delay network establishes the correct time relationship between the transmitted L + R and L - R signals for channel separation.

**System Details.** So far, we have enumerated only the similarities between the various competing AM-stereo



**Fig. 3. Kahn (ISB)**



The L + R signal goes to a -45° phase-shift network and is applied to the audio inputs of a standard transmitter. The L - R information passes through a +45° phase-shift network. At this point, the L + R and L - R signals are 90° out-of-phase with each other. The L - R component feeds a summation network and controls an agc circuit. A variable time-delay network is inserted in the output of the summation amplifier to equalize the delays between the L - R and L + R signal paths.

The output of an oscillator that operates at a submultiple of the standard broadcast transmitter's frequency is applied to a phase modulator. The L - R audio signal from the time-delay network is then applied. The PM signal is brought up to the carrier frequency by a frequency multiplier. The PM carrier is then routed to the transmitter.

Kahn discovered that a further improvement in channel separation was possible by adding a second-harmonic phase-modulated component. Independent left and right audio signals are routed through differential phase networks with zero relative phase. The second-harmonic component is obtained from constant-amplitude frequency doublers, the outputs of which are applied to a difference network, followed by a level squarer.

The level squarer is essentially an agc

amplifier whose gain is controlled by a sample of the L - R signal. The agc amplifier supplies the proper amount of second-harmonic component to optimize separation. When the audio signals are equal and in-phase, the L - R component is zero and correspondingly reduces the agc's gain to zero. (This would be the case with mono audio.) When both channels are present and in-phase but not equal, the agc amplifier's gain is only partially reduced.

Kahn developed the ISB system with the objective that two ordinary mono AM receivers could be used to receive stereo. One receiver could be used to tune the lower sideband for the left channel and the other to tune the upper sideband for the right channel. Single AM receivers would need only be tuned on-carrier for mono L + R reception.

The ISB signal can also be recovered with a single receiver. Kahn has outlined various ways in which this can be accomplished. One reception scheme incorporates independent i-f stages. Another scheme employs a single i-f section, as shown in Fig. 3B.

Kahn Communications developed one of the first AM-stereo systems. Leonard Kahn petitioned the FCC for adoption of AM stereo as early as 1959. Since then, he has field tested his AM-stereo on WFBT (Baltimore, MD) and XETRA (Tijuana, Mexico).

Motorola (C-QUAM). Motorola has developed yet another technique for transmitting and receiving AM stereo. Its C-QUAM (Compatible Quadrature Modulation) system is perhaps the most convenient means for transmitting two signals on one carrier. Quadrature modulation is perhaps best known for its application to color television, where two separate color signals are transmitted on a redundant single subcarrier.

To best understand the C-QUAM system, let us first look at an AM-stereo system that uses basic quadrature modulation. (This basic discussion on quadrature modulation also applies to the Harris AM-stereo system, which uses modified quadrature modulation.)

A system for transmitting two signals in quadrature is shown in Fig. 4A. Here, two separate transmitters are fed from a single carrier oscillator, with the phase of one carrier leading the other by 90°. One AM transmitter is modulated with left- and the other with right-channel information. The respective outputs are combined and broadcast by a common antenna. The use of two independent transmitters for generation of quadrature modulation is not necessary for practical applications. At the receiver (Fig. 4B), each carrier is detected to derive the left and right audio channels.

AM-stereo quadrature modulation presents a problem in compatibility with

## AM STEREO *Continued*

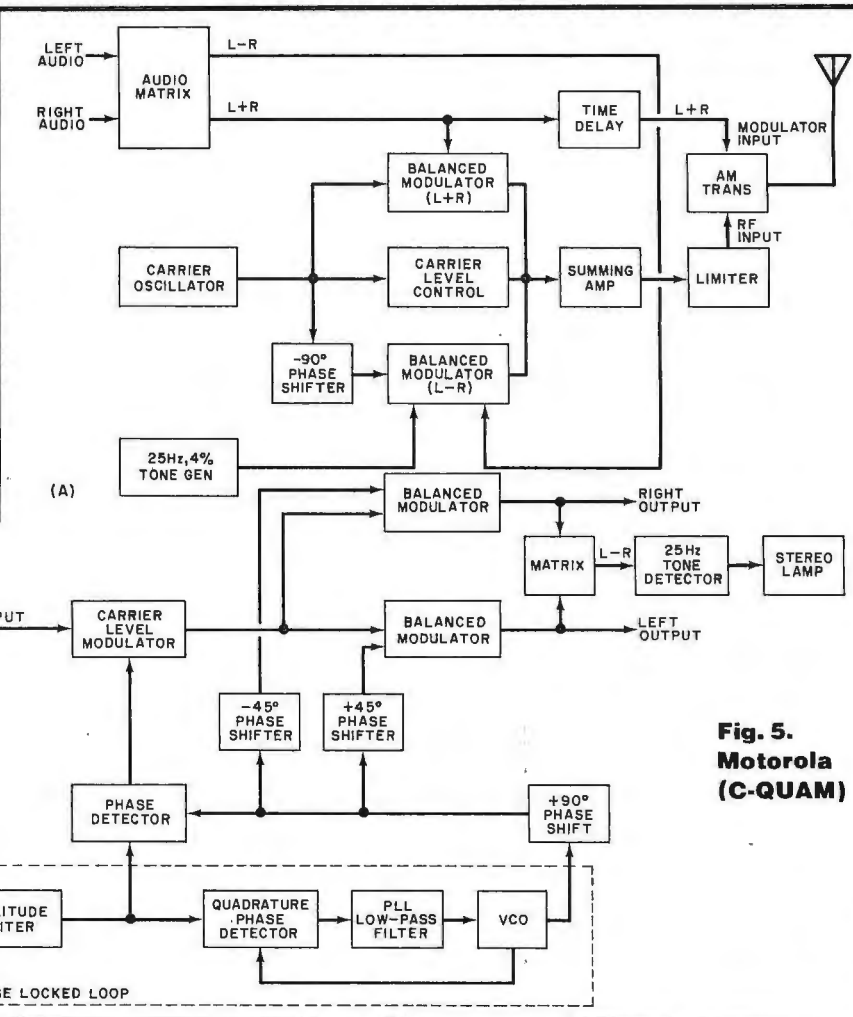
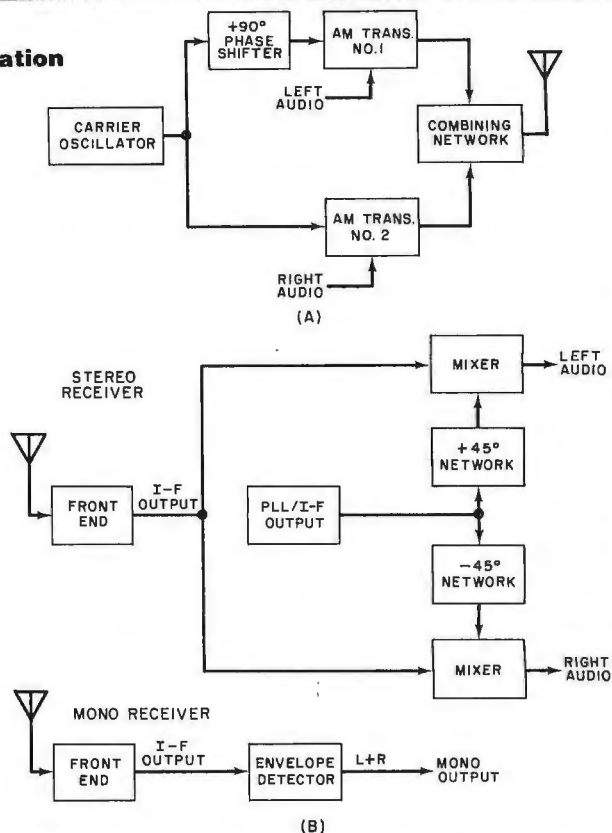
today's envelope detectors. An envelope detector is a nonlinear device that generates distortion when the quadrature signal contains a significant amount of stereo information. The signal recovered from the mono envelope detector is not the linear sum of L and R and it can also contain a significant amount of distortion (28% maximum). The C-QUAM system attempts to overcome this problem.

In the proposed C-Quam AM-stereo generator (Fig. 5A), the left and right channels are applied to the familiar audio matrix. One carrier is amplitude modulated with  $L + R$  audio and another carrier is phase shifted by  $90^\circ$  and amplitude modulated by  $L - R$  audio.

The  $L + R$  and  $L - R$  sidebands from the balanced modulators are combined with the carrier in a summing amplifier. The output of this amplifier is limited to remove AM components. The resultant phase-modulated carrier signal is used in place of the transmitter's crystal oscillator. The  $L + R$  information from the matrix is applied to a time-delay network and then to the transmitter.

The C-QUAM system overcomes the mono envelope-detector distortion problems associated with conventional quadrature modulation. The C-QUAM system inherently generates distortion products when it amplitude modulates the PM carrier. These distortion products cancel quadrature distortion in an envelope detector if they are received in the same relative phase and amplitude relationships. This design philosophy has two shortcomings. First, it places critical phase and amplitude requirements on the receiver's i-f section. Secondly, the generated distortion products that cancel the mono envelope detector's distortion appear in the stereo receiver. These distortion terms must be

**Fig. 4. Basic Quadrature Modulation**



**Fig. 5. Motorola (C-QUAM)**



corrected, for which processing circuits are required in every C-QUAM receiver.

The C-QUAM AM-stereo signal can be received by using synchronous detectors, as shown in Fig. 5B. The receiver's i-f is applied to a carrier level modulator and an amplitude limiter. A voltage-controlled oscillator (vco) is locked in-phase with the i-f carrier. The outputs of the vco and limiter provide input signals for the phase-detector circuit. The phase detector and the necessary low-pass filter keep the vco locked in phase quadrature with the i-f carrier signal.

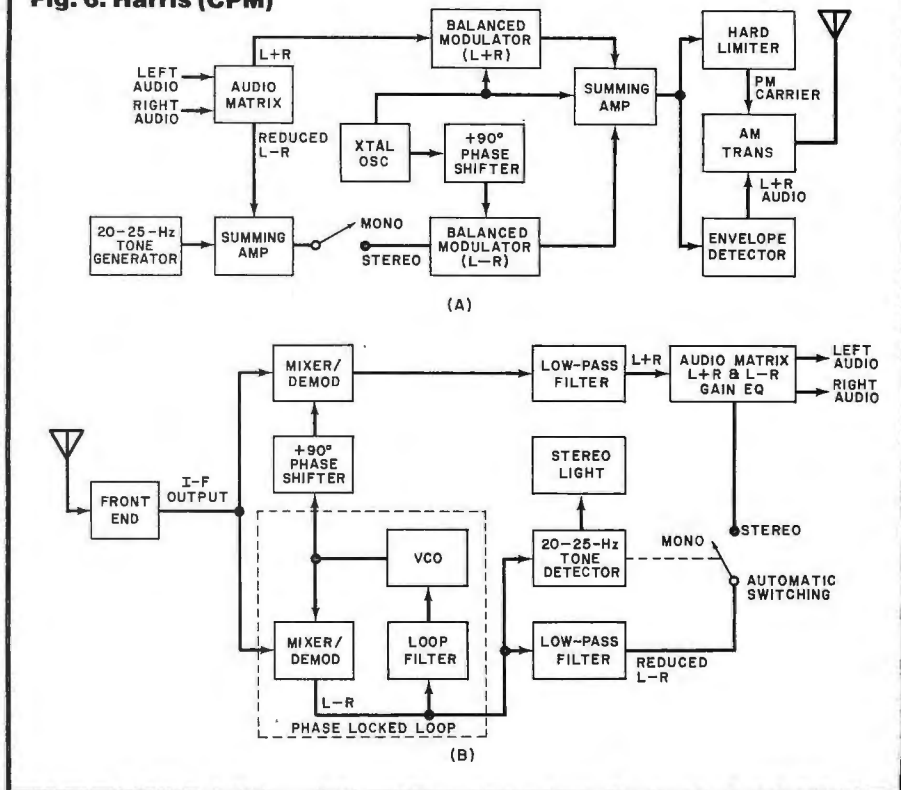
The vco's output is shifted  $90^\circ$  to provide a signal that is in-phase with the receiver's i-f signal. The phase-shifted vco signal is used with a signal from the amplitude limiter to feed the phase detector, which, in turn, drives the carrier level modulator. The carrier level modulator is simply a multiplier that converts the C-QUAM i-f signal to a quadrature i-f signal. The left and right signals can be recovered by synchronous detectors. The synchronous detectors (balanced modulators) are supplied with the quadrature i-f signal and i-f carrier generated by the vco and shifted by  $\pm 45^\circ$ .

The left and right outputs of the balanced modulators can be routed to the audio amplifier. To recover the stereo identification signal, sample left and right signals are matrixed together. The matrixed  $L - R$  signal feeds a 25-Hz tone detector. The stereo ID tone then turns on a stereo indicator in the receiver and would possibly operate a stereo/mono switch in the input to the audio amplifiers.

**Harris (CPM).** The Harris Compatible Phase Multiplex (CPM) system is a linear-additive quadrature modulation scheme. The CPM system amplitude modulates two carrier signals separated in phase by  $30^\circ$ . The left-channel signal amplitude modulates a carrier that lags the transmitted resultant by  $15^\circ$ , and the right-channel signal modulates a carrier that leads by  $15^\circ$ . These two signals are linearly combined (added) to form the CPM signal. This makes Harris' the only proposed linear system.

One method of generating the CPM signal is illustrated in Fig. 6A. An audio matrix produces  $L + R$  and reduced  $L - R$  components. A low-level, low-frequency stereo ID tone is inserted in the  $L - R$  component in a summation amplifier. The 20-to-25-Hz tone is used only for AM stereo signaling purposes. The tone is not heard in mono receivers because it is in the  $L - R$  channel only. It will not be heard with stereo receivers because it appears out-of-phase on the

**Fig. 6. Harris (CPM)**



two channels and cancels out in the listening environment. Hence, little or no filtering is required in stereo receivers.

The  $L - R$  component is applied to a balanced modulator along with a  $+90^\circ$  phase-shifted carrier. The  $L + R$  information is also applied to a balanced modulator along with a normal carrier. The outputs are summed with the proper amount of carrier to produce the CPM signal. The low-level CPM signal could be transmitted as if it were followed by a linear amplifier. However, the interface requirements with current AM transmitter prohibits this.

To interface with current AM transmitters, the CPM signal is separated into envelope and phase-modulated components. An envelope detector derives  $L + R$  information from the CPM signal that is applied to the audio input of the transmitter. The CPM signal is also processed through a hard limiter to remove the AM component and yields a PM carrier signal that is used in place of the crystal oscillator in the transmitter.

The reduction in gain in the  $L - R$  quadrature channel is the key to providing compatibility with mono receivers and envelope detectors. When the CPM stereo signal is received on a mono receiver using an envelope detector, some distortion (typically 0.5%) results due to the presence of quadrature sidebands. If the  $L - R$  quadrature component were

not reduced in transmission, the distortion would be about 11%.

Stereo receivers for the Harris CPM system will use synchronous detectors, rather than envelope detectors, to obviate any distortion in the stereo and mono modes. Such a stereo receiver is detailed in Fig. 6B, which illustrates one of the several ways to recover the CPM signal. Unlike the case for the four other receivers, the CPM receiver does not require the more costly front ends with equal amplitude and phase characteristics to receive low-distortion stereo.

The receiver's i-f signal is first applied to a synchronous detector. The detector serves two purposes. First, it works as a phase detector for the phase-locked loop made up of the loop filter and vco. The vco is locked to the i-f and oscillates  $90^\circ$  out-of-phase with the incoming i-f signal. Secondly, the balanced modulator directly demodulates the quadrature  $L - R$  part of the signal. The vco's output signal is shifted  $90^\circ$  and used to demodulate the in-phase  $L + R$  component of the signal. Low-pass filters remove all carrier frequency components from the output of the detectors. The  $L + R$  and  $L - R$  signals are combined in a simple audio matrix to recover independent left and right channels. Amplitude equalization of the reduced  $L - R$  component also occurs in the matrix.

The stereo ID tone can easily be re-

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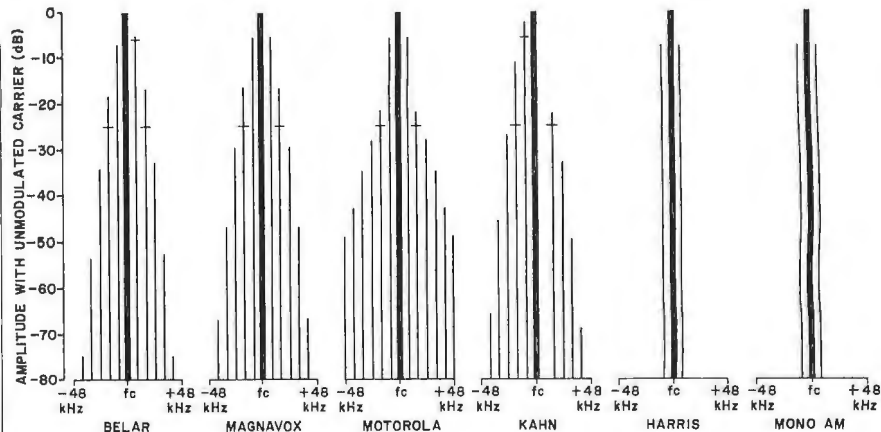


Fig. 7. Transmitted spectra of proposed AM stereo systems. Bar through spectral line indicates point that exceeds existing FCC limits for radiated sideband power.

covered. An L - R sample is applied to a 20-to-25-Hz detector, which turns on a stereo indicator and can activate a stereo/mono mode switch.

**Now and the Future.** The five AM-stereo systems described here have all been field tested. Each system has its own advantages and disadvantages. In its technical evaluation, the FCC will consider a number of performance factors. Paramount among these will be the amount of increase in occupied channel bandwidth; mono and stereo receiver distortion under skywave, selective fading, narrow bandwidth, and mistuning conditions; and stereo separation, fre-

quency response, and noise under various receiving conditions.

adoption and approval of an AM-stereo system based on these and other criteria could occur as early as the spring of 1979.

While the five contenders have been active in designing, testing, and promoting their systems, receiver manufacturers have not been idle. Several receiver manufacturers, including Pioneer and Sansui, have already recommended to the FCC adoption of the Harris AM-stereo system because of its technical advantages. Most receiver manufacturers, however, are taking few chances and have breadboarded most of the competing systems. The major semiconductor manufacturers are also gearing up for this new market by designing single-chip AM-stereo detector ICs.

AM stereo will do more than just bring to the public a new two-channel sound medium. It will also usher in higher quality of sound than was heretofore generally available with AM, and greater realism through two-dimensional sound reproduction. The new receivers may have a virtually flat audio response out to 10,000 Hz, compared with current AM receivers whose response is often down 20 dB at 5000 Hz.

The automotive market presents the greatest potential for AM-stereo receivers since AM signals now cover areas where FM does not penetrate.

Receiver manufacturers plan to have AM-stereo receivers on the market two to three months after final FCC approval. AM-stereo receiver marketing estimates go as high as \$20-billion to supplement the 425-million mono AM receivers already in use today.

The FCC's decision to adopt AM stereo will undoubtedly have an enormous impact on the radio-listening public. The repercussions are expected to be similar to those at the time the FCC approved color television.

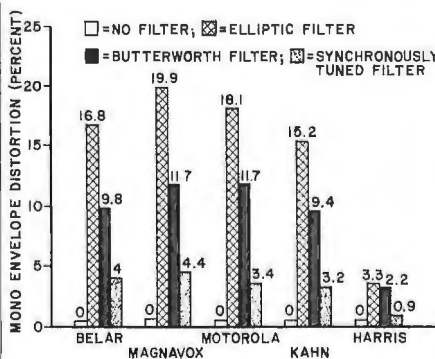


Fig. 8. Monophonic envelope detector distortion through various i-f filters.

quency response, and noise under various receiving conditions.

Other conditions that are certain to come under the FCC's scrutiny include: amount of reduction in mono service area; system implementation into current and future AM receiver designs; and the use of a stereo pilot for indicator lights and/or stereo/mono switching.

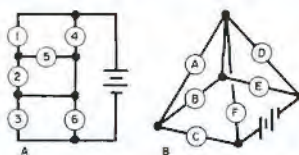
System comparison charts and graphs are given in Figs. 7 and 8. Final



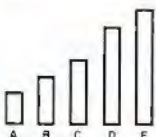
# Electronics IQ QUIZ

**1** Lamp circuits A and B are electrically identical. Can you determine which lamp in circuit B corresponds with lamp number 5 in circuit A?

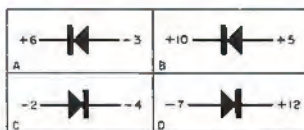
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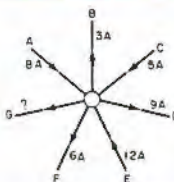
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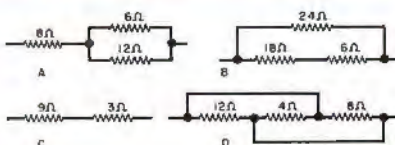
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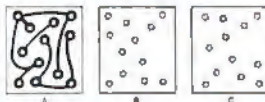
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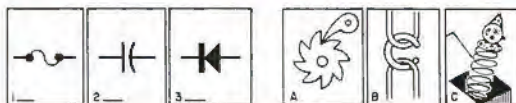
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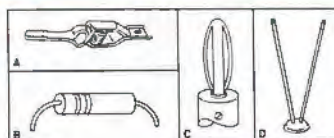
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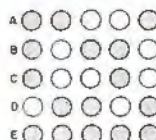
**8**



**9**



**10**



**2** The lengths of the bars (A-E) represent the resistance values of a group of resistors. If resistors B and D are combined in parallel, which bar would represent the resistance of the combination?

**3** Which diode circuit (A-D) does not belong in this group?

**4** Can you determine the magnitude of current G leaving the circuit junction?

**5** Which of these resistor combinations (A-D) does not belong in this group?

**6** If sketch A is the foil side of a pc board, which sketch, B or C, is the reverse, or component, side?

**7** What reading is indicated on this kilowatt-hour meter?

**8** Match the electronic component symbols (1-3) with their corresponding mechanical analogies (A-C).

**9** Which electronic component does not belong in this group?

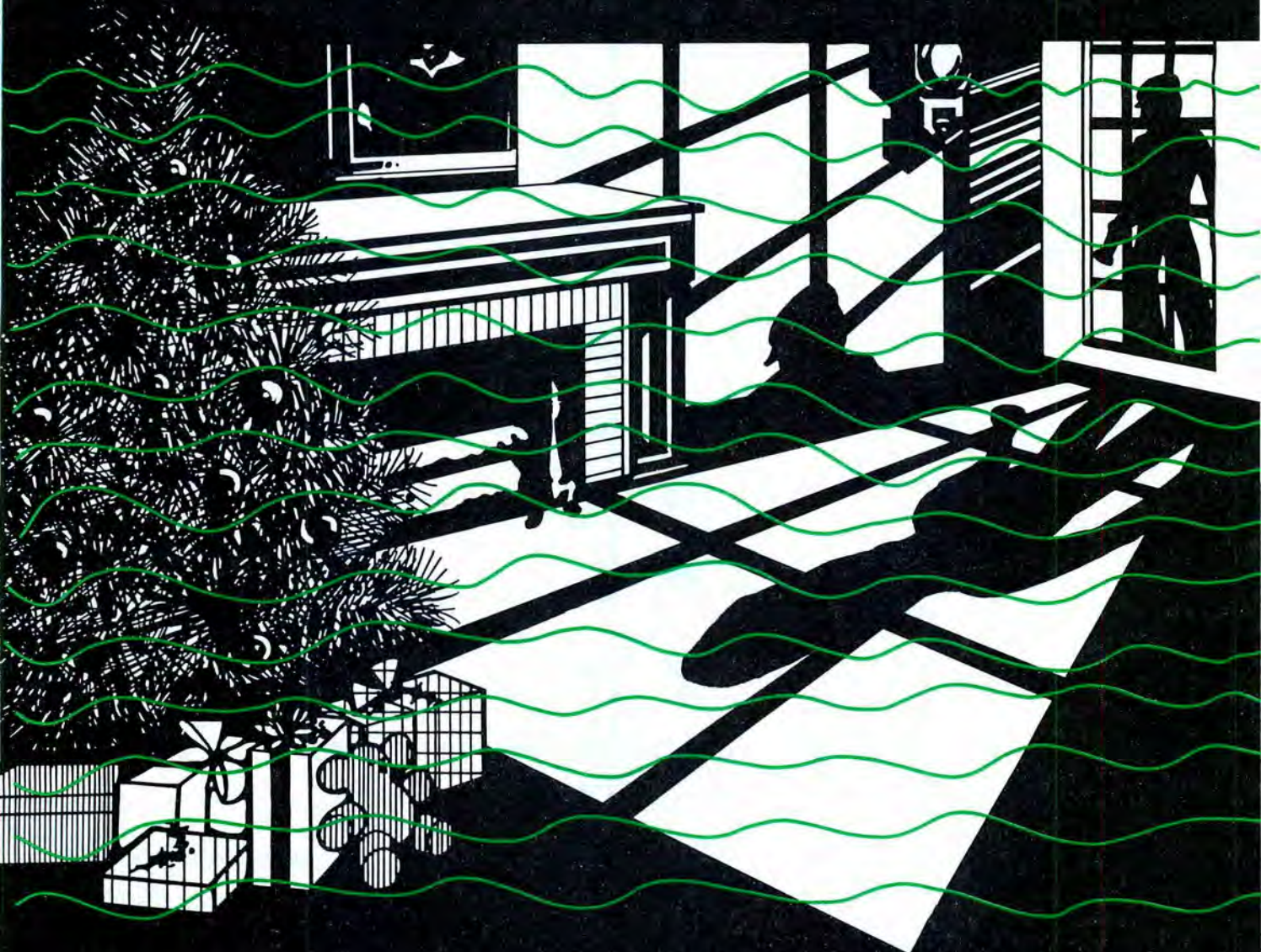
**10** If the first five rows of lamps (A-D) use the binary code (a lighted lamp is a 1) to indicate the numbers in a mathematical series, what number should row E indicate?

(Answers on page 100)



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# TWO ELECTRONIC SYSTEMS TO PROTECT YOU AND YOUR PROPERTY AN INFRARED INTRUSION SYSTEM



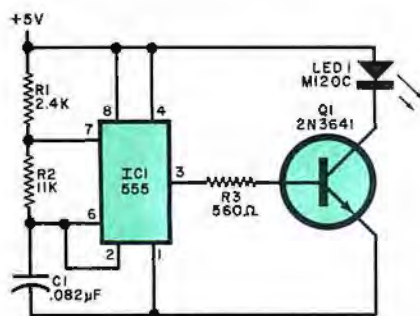
**T**HE INTRUSION system described here uses an invisible infrared-beam design. When aimed across a doorway, window, or other area under surveillance, it is like having an invisible trip wire attached to an alarm system. To prevent intruders from using another infrared light source in an attempt to "fool" the alarm, the system uses a 700-Hz modulation of the invisible surveillance beam. The operating range can be as much as 50' (15.2 m) between transmitter and receiver.

**Modulated invisible light beam...a  
protection range up to 50 feet**

**Circuit Operation.** The infrared transmitter shown in Fig. 1 employs a conventional 555 timer (*IC1*) to control *Q1*, the LED driver, at a frequency of about 700 Hz. Since the waveform is adjusted to be nearly square, the average LED current is about 50 mA. (The LED is on about 0.7 ms and off about 0.7 ms.)

**BY HANK OLSON**





## TRANSMITTER PARTS LIST

C1—0.082-µF disc  
 IC1—555 timer  
 LED1—Discrete infrared light-emitting diode (Monsanto MI20C or ME60 or Motorola HEP P2002)  
 Q1—2N3641 transistor  
 R1—2400-ohm, 10%, 1/2-watt resistor  
 R2—11,000-ohm, 10%, 1/2-watt resistor  
 Misc.—Suitable box (LMB 140 or similar); lens; brass tubing, etc.  
 Note: Four lenses are available for \$5.00 ppd from Hank Olson, P.O. Box 339, Menlo Park, CA 94025.

Fig. 1. Timer drives Q1 to turn on LED in simple transmitter.

The receiver shown in Fig. 2 employs quad operational amplifier IC1, section A of which is used as a high-input-impedance noninverting  $\times 31$  voltage-gain amplifier. Phototransistor Q1 is coupled through C1 to the noninverting (+) input of IC1A. Stage IC1B is used as an active bandpass filter whose center frequency is at 700 Hz. This filter has a voltage gain of 10 and a Q of 10 and is tunable to a degree by TUNING control R7 so that its operating frequency can be matched to the frequency of the transmitted signal.

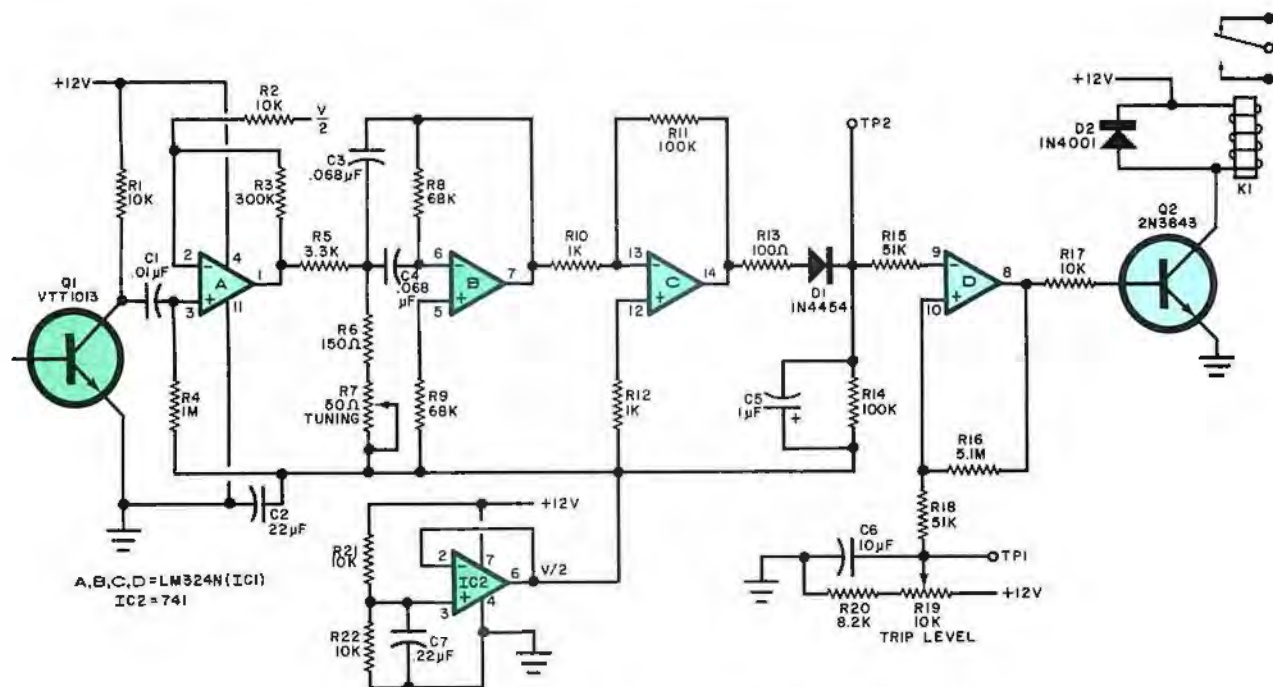
The amplified and filtered signal goes to  $\times 100$  amplifier IC1C to produce additional gain. Diode detector D1 and its associated time-constant components convert the 700-Hz ac signal to a dc voltage to drive Schmitt trigger IC1D. The trip level of IC1D can be adjusted via TRIP LEVEL control R19 between +5.5 and almost +12 volts. When the dc voltage at TP2 exceeds the voltage at TP1, the output of IC1D at pin 8 is near zero. When the dc voltage at TP2 is less than the preset voltage at TP1, IC1D's output

is almost +12 volts, at which point, Q2 conducts and energizes K1.

Since IC1 operates with a 12-volt power supply (rather than its normally rated  $\pm 6$ -volt supply), IC2 is used to generate V/2 (6 volts) at a low impedance. Note that the output of IC2 is always half the supply voltage, even if that voltage changes slightly. It also supplies V/2 potential at low impedance, without consuming the large amounts of current that would be the case with a resistive voltage divider.

The +5-volt power supply for the transmitter is shown in two versions in Fig. 3. The ac-only version in A employs a simple rectifier/filter and a common three-terminal voltage regulator. The +12-volt ac supply for the receiver is shown in Fig. 4A.

Parts B of Figs. 3 and 4 illustrate an ac plus standby battery supply that automatically switches the transmitter/receiver from line to battery power if the power line should fail or be cut. In the switchover circuits, a simple emitter-follower regulator uses the standby battery



## RECEIVER PARTS LIST

C1—0.01-µF disc  
 C2, C7—0.22-µF disc  
 C3, C4—0.068-µF disc  
 C5—1-µF, 15-V electrolytic  
 C6—10-µF, 15-V electrolytic  
 D1—IN4454 diode  
 D2—1N4001 rectifier diode  
 IC1—LM324 quad op-amp  
 IC2—741 op-amp  
 K1—12-volt, 250-ohm relay

Q1—VVT-1013 (Vactec), MRD450 (Motorola), or HEP P0003 (Motorola) phototransistor  
 Q2—2N3643 or HEP-S30015 transistor  
 The following resistors are 10%, 1/2-watt:  
 R1, R2, R17—10,000 ohms  
 R3, R11, R14—100,000 ohms  
 R4—1 megohm  
 R5—330 ohms  
 R6—150 ohms  
 R8, R9—68,000 ohms

R10, R12—1000 ohms  
 R13—100 ohms  
 R15, R18—51,000 ohms  
 R16—5.1 megohms  
 R20—8200 ohms  
 R7—50-ohm potentiometer  
 R19—10,000-ohm potentiometer  
 R21, R22—10,000-ohm, 1% resistor  
 Misc.—Sockets for ICs; lens; telescoping tubing; suitable box (Bud AC-429 or similar).

Fig. 2. When the dc voltage at TP2 of IC1D goes low, Q2 conducts to energize K1.



Photo shows author's prototype system with receiver at left. Relay contact ratings will determine type and size of alarm that can be connected. Binding posts are for standby-battery power supplies. Test-point holes are located on top of receiver.

as a voltage reference, which consumes very little current, while the main current is passed through the emitter-follower from collector to emitter. When the ac line fails, the base-emitter junction of the emitter-follower acts as a diode to conduct the required current from the battery to the circuit. In the Fig. 3B power supply for the transmitter, a 5-volt regulator because of the voltage/frequency sensitivity of the 555 timer. Fuse *F2* and diode *D1* are included in the base circuit to protect against inadvertent battery-polarity reversal.

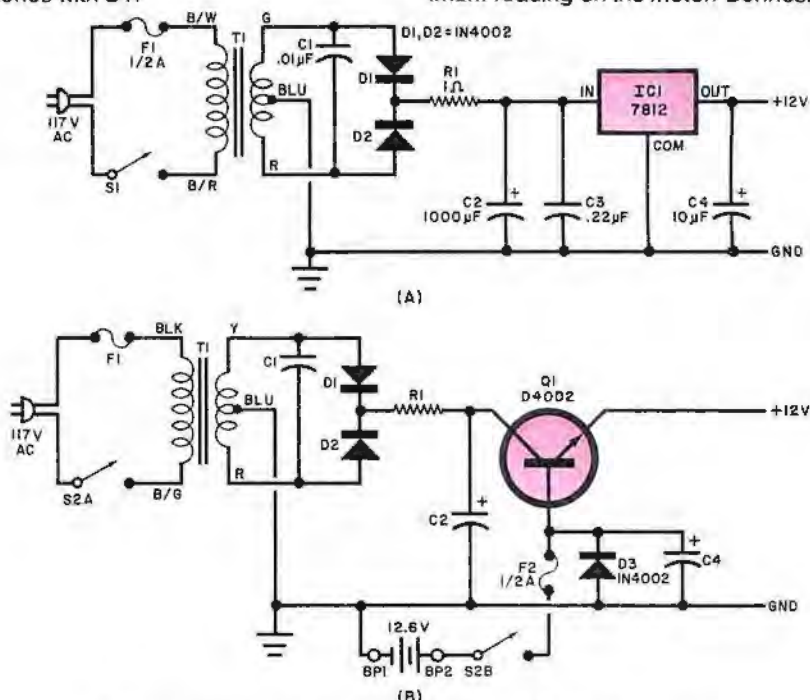
By adding a resistor between the base and collector of the emitter-follower, a float charge can be used by the rechargeable standby battery. The battery manufacturer's charging specifications can be met by varying the voltage of the transformer and the value of the resistor between the collector and base.

**Construction.** The transmitter and receiver can be assembled as desired on perforated board or small printed-circuit boards of your own design. Mount LED1 in the transmitter where it can be "beamed" through a lens hole cut into the wall of the box in which the transmitter is housed. Similarly mount Q1 in the receiver's box so that its sensitive surface "looks" through a lens hole. Details for the lens system to use in both the transmitter and the receiver are shown in Fig. 5. Position a small piece of Kodak Wratten #87 filter between the lens and the phototransistor in the receiver to exclude visible light.

**Setting Up.** Connect a triggered-

sweep oscilloscope or a frequency counter to pin 3 of capacitor IC1 in the transmitter. With power applied to the circuit, the measured frequency should be very close to 700 Hz. If it is not, slightly alter the value of capacitor C1 by adding a low-value capacitor either in shunt or in series with C1.

Remove the lenses from the system and aim the LED in the transmitter at the phototransistor in the receiver, spacing the two about a foot apart. Connect a high-impedance multimeter (VTVM, DMM, etc.) to TP2 in the receiver (Fig. 2) and adjust potentiometer R7 for a maximum reading on the meter. Connect the



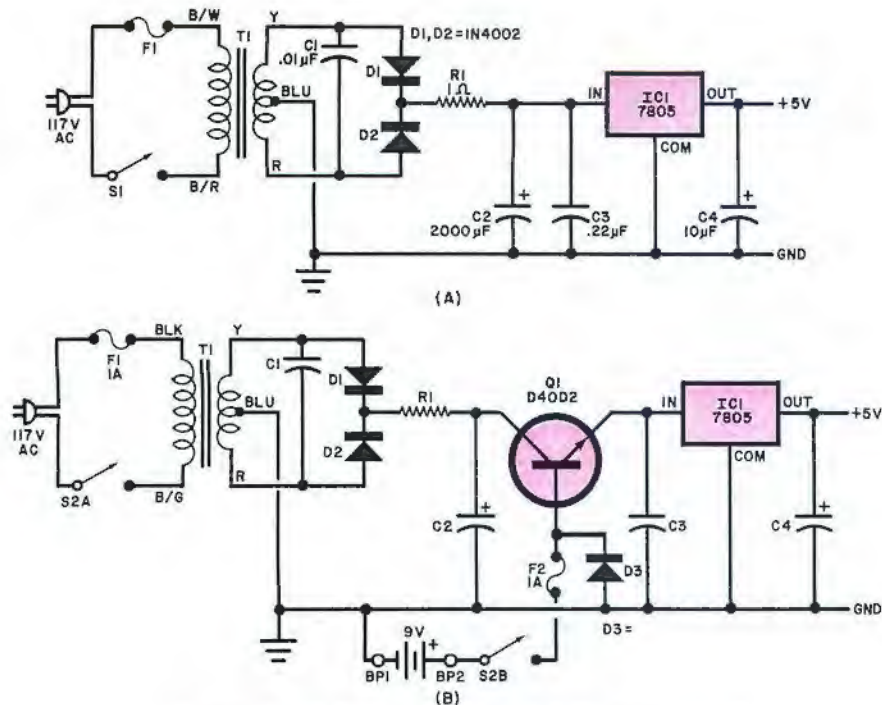
### TRANSMITTER POWER SUPPLY PARTS LIST

BP1, BP2—Five-way binding post  
C1—0.01-μF, 1-kV disc  
C2—2000-μF, 15-V electrolytic  
C3—0.22-μF  
C4—10-μF, 10-volt tantalum  
D1, D2, D3—1N4002 rectifier diode  
F1, F2—1-ampere fuse and holder

IC1—7805 5-volt regulator  
Q1—HEP S5000 (Motorola) or D40D2 (GE) transistor  
R1—1-ohm, 10%, 1/2-watt resistor  
S1—Sps switch  
S2—Dps switch  
T1—Triad No. F90X transformer.

Fig. 3. Ac-only version of power supply is shown at (A). Circuit (B) has provision for standby battery operation.





### RECEIVER POWER SUPPLY PARTS LIST

BP1, BP2—Five way binding post  
 C1—0.01-μF, 1-kV disc  
 C2—1000-μF, 25-volt electrolytic  
 C3—0.22-μF  
 C4—10-μF, 15-volt tantalum  
 D1, D2, D3—1N4002 rectifier diode  
 F1—1/2-ampere fuse and holder

IC1—7812 12-volt regulator  
 Q1—HEP S5000 (Motorola) or D40D2 (GE) transistor  
 R1—1-ohm, 10%, 1/2-watt resistor  
 S1—Spst switch  
 S2—Dpst switch  
 T1—Triad No. F9OX transformer

Fig. 4. Ac power supply (A) and battery standby circuit (B).

meter to TP1 and adjust potentiometer R19 for a 6.2-volt meter reading. Insert the lenses into the transmitter

and receiver and separate the two units by about 10' (3 m). Aim the lensed output of the transmitter at the lensed input

of the receiver and, with the meter connected to TP2, adjust the aiming and lens extension of each unit to maximize the meter reading. Any level at TP2 that is in excess of 6.2 volts set up via R19 should cause K1 to open. You can check this by interrupting the beam with your hand and listening for the click of

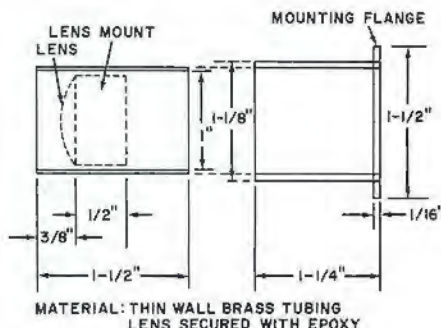


Fig. 5. How to construct the lens systems for receiver and transmitter units.

the relay. This fail-safe approach is used so that an alarm will be powered if the 700-Hz modulated infrared beam is interrupted for any reason.

The system as designed here has been used at distances up to 50' between the transmitter and receiver with the two lenses carefully aligned. This distance should be adequate for most surveillance applications. ◇

BY JOHN HOLLABAUGH

## A PORTABLE ALARM FOR SINGLE ENTRIES

**S**ILENCE is a primary requirement of a successful burglary. There are many intrusion alarms on the market to break this silence. The one described here is a special-purpose device—a portable door alarm that's especially useful for apartment dwellers or persons

who travel and thus stay frequently at motels or hotels.

The alarm is designed to be hung on the inside doorknob of the entry door. It is tripped by anyone touching the knob or inserting a key. The alarm will sound off even if the would-be intruder wears

rubber gloves. Once tripped, the device cannot be disabled until its reset push-button is pressed.

The advantages of such an alarm are: (1) portability; (2) operation independent of the ac power line; (3) easy construction; and (4) low cost. The alarm can be

Small, battery-operated alarm is sounded by intruder's contact with doorknob.

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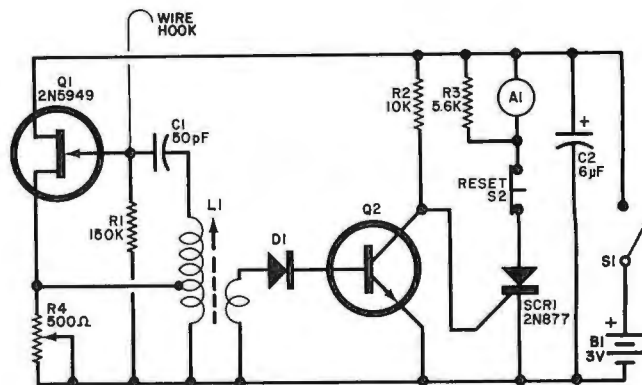
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### PARTS LIST

- |  |  |
|--|--|
| A1—1.5-volt buzzer                     | R2—10,000-ohm, 1/4-watt, 10% resistor  |
| B1—Two 1.5-volt cells in series        | R3—5600-ohm, 1/4-watt, 10% resistor  |
| C1—50-pF disc                          | R4—500-ohm trimmer potentiometer   |
| C2—6-μF, 15-volt electrolytic          | SCR1—2N877 or similar 0.5-ampere silicon controlled rectifier  |
| D1—Any germanium diode                 | S1—Spst switch   |
| L1—See text                            | S2—Normally closed pushbutton switch   |
| Q1—2N5949 or similar FET               | Misc.—Small plastic case; heavy bare copper wire (for hook); machine hardware; hookup wire; solder; etc. |
| Q2—Low-power npn germanium transistor  |  |
| R1—150,000-ohm, 1/4-watt, 10% resistor |  |

*Output of Hartley oscillator (Q1) keeps SCR1 from firing until the impedance at R1/C1 is changed by contact with hook and oscillations cease.*

powered by two 1.5-V rechargeable batteries, which in the author's experience provide about ten 24-hour days of operation before requiring recharging.

**Circuit Operation.** As shown in the schematic diagram, the alarm's circuit consists of a Hartley oscillator made up of Q1, L1, R1, and C1. The output of the oscillator is generated across the secondary of L1 and is rectified by D1. The rectified signal is then used to forward bias Q2 so that the transistor's collector-emitter voltage is almost zero. This bias voltage is applied to the gate of SCR1, which, because the gate voltage is very close to the anode voltage, prevents the SCR from firing.

The C1/R1 junction and gate of Q1 represent a high r-f impedance that can easily be changed by the contact of any r-f-absorbing object, such as the human hand. The sensitivity of this reaction is controlled by R4, which is connected across the feedback winding of L1.

When the r-f oscillator is loaded by contact with the "hook" (a short metallic connector to the high-impedance junction), the oscillations cease and remove the positive voltage applied to the base of Q2. When this occurs, Q2's collector goes positive. This voltage is applied to the gate of SCR1 to trigger the SCR into conduction. Current now flows through alarm A1, RESET switch S2, and SCR1. Because SCR1 is powered from a dc

source, it will continue to conduct until the RESET switch is operated to momentarily break the conduction path and turn off SCR1.

**Construction.** The alarm's circuit can be built on any small perforated board or a printed-circuit board of your own design. Be sure, however, to observe good r-f wiring practice, keeping lead lengths as short as possible. (Almost any AM-broadcast-band transistor-radio coil that has a low-impedance secondary winding can be used for L1.)

The small board, alarm, POWER and RESET switches, and two 1.5-volt cells can be installed in a small plastic box. The hook can be made from a length of heavy bare copper wire, fed through a hole in the box and soldered to the R1/C1/Q1-gate junction.

**Checkout.** Place the case in a position so that the wire hook is vertical and away from all metal objects. With the power turned on, touch the hook with your hand. This should cause the alarm to sound. When you press the RESET switch (with your hand away from the hook), the alarm should cease sounding. Adjust potentiometer R4 for the desired tripping sensitivity.

The alarm should be used with metal doorknobs on wooden doors. (All-metal doors may present too much of a load for the alarm's pickup.) ◇



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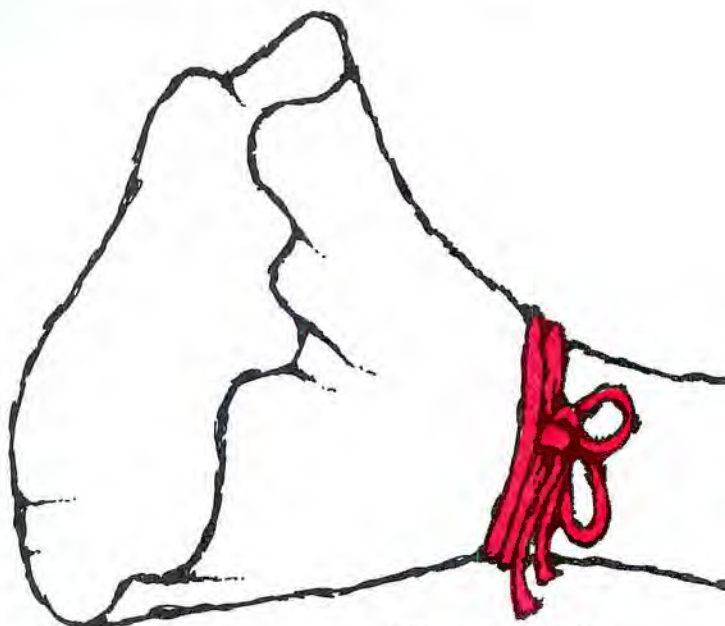
# Holiday Season Electronic Gifts PE Editors Wish They'd Receive...

**W**HAT would you like to receive as Christmas gifts from among the multitudes of electronics products on the market? Posing this question to seven editors and the publisher of POPULAR ELECTRONICS was very revealing.

Like many readers, they own an exceptionally large number of electronics products due to their affinity for all things electronic. So the products they'd like to receive as gifts, whether purchased by a loved one or bestowed upon one's self, were very selective. It was largely influenced by what they already owned, their present activities, and what they would like to get into in the broad field of electronics.

The only condition set down for this informal survey was that their choices be made on the basis of likely monies available to be spent rather than a selection of "dream" products beyond their financial reach. Two choices were permitted for each of the following electronics products categories: Communications, audio, computers, test instruments, miscellaneous (costly), miscellaneous (inexpensive). Duplicated selections are not noted here.

How do your choices compare? To help you drop some pointed, innocent hints to, say, your wife, we've included a sample "What I'd Like As A Gift" form that you can cut out and place in a location that can be seen by your target donor.







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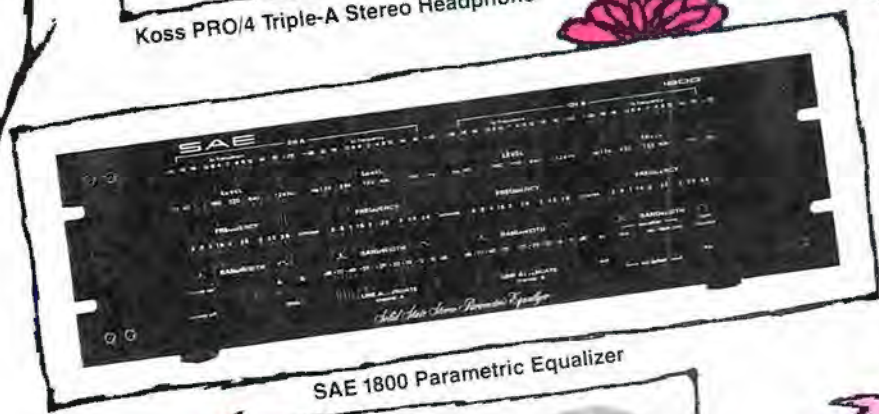


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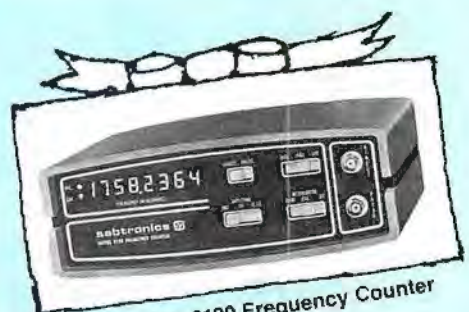
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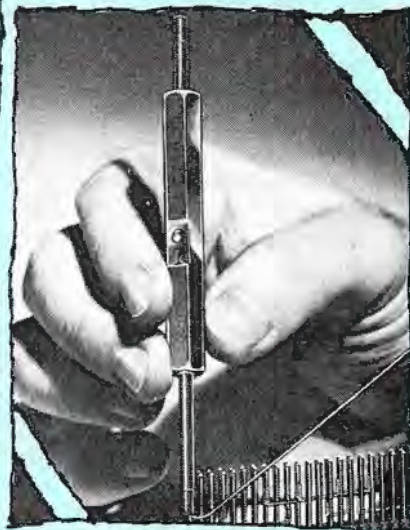
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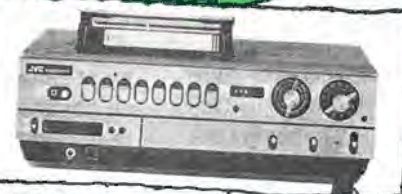
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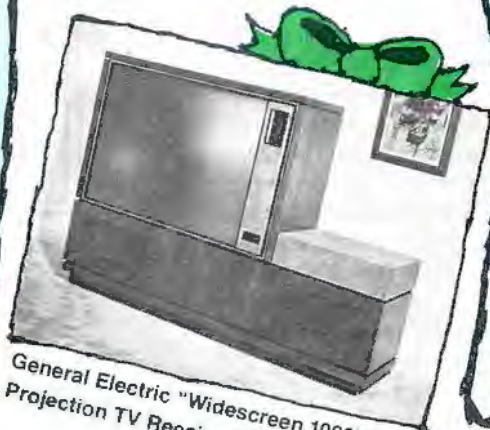
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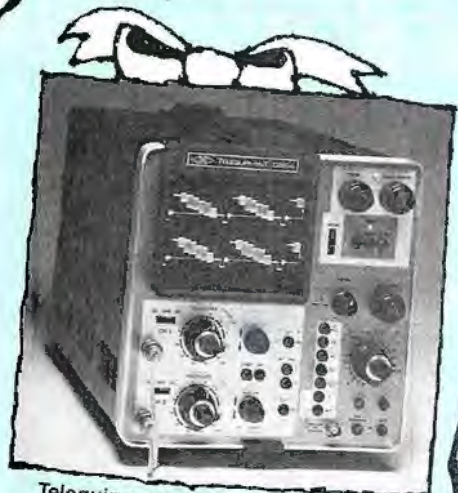
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General Electric "Widescreen 1000" Projection TV Receiver



Wahl "Iso-Tip" Cordless Solder Iron



Telequipment (from Tektronix) D66A Dual-Trace Oscilloscope



Pioneer TVX-9500 TV Sound Tuner





# Solid State

By Lou Garner

## HOLIDAY PROJECTS

WITHOUT question, the most precious gifts are those with a personal touch. For example, hand-crafted bookends express one's feelings much better than a mass-produced set from a department store. With this thought in mind, last December's column was devoted to simple circuits suitable for hobbyist gift projects. The reaction was surprisingly positive in the form of reader correspondence and phone calls. Such an enthusiastic response demands an encore. So for this Holiday Season, another visit to our treasure trove of useful circuits!

A relatively new device from Texas Instruments, Inc. (Box 5012, Dallas, TX 75222) offers some exciting possibilities for simple gift projects. Identified as the type TL489C Analog Level Detector, the inexpensive IC consists of five comparators and output drivers along with a reference voltage network in a single 8-pin plastic miniDIP.

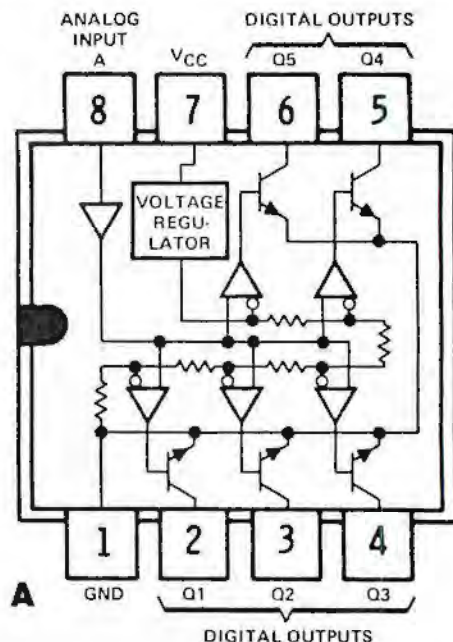
Referring to the block diagram and function table given in Figs. 1A and 1B, respectively, the TL489C accepts a positive analog dc input signal at terminal A (pin 8) and switches open collector outputs Q1 through Q5 (pins 2 to 6) from high to low levels in steps with an increasing input voltage. Initially, all outputs are high (i.e., switch open). When the input voltage increases to a nominal level of 200 mV, Q1 switches to low (that is, on or conducting).

Afterwards, Q2 switches low when the input is raised to 400 mV, Q1 remaining low. Next, Q3 switches low when the input is raised to 600 mV, and so on, until all five outputs are low with an input of 1000 mV (or 1 volt). The input level can be increased up to a maximum of 8.0 volts without damage, but there will be no further change in the outputs. If the input voltage is lowered, however, the reverse action will take place. Here, Q5 returns to a high state when the input voltage drops to approximately 800 mV. This is followed similarly by Q4, Q3, Q2, and Q1, as the input voltage is decreased to near zero. Each output can withstand up to 18 volts, sinking up to 40 mA, and is thus capable of driving LEDs, low-power incandescent lamps, sensitive relays, Sonalert alarms, and power transistors as well as all standard logic families (TTL, CMOS, etc.). The device has an (analog) input impedance of approximately 100,000 ohms, and is suitable for operation on dc sources of from 10 to 18 volts.

The TL489C is especially designed to detect and indicate analog voltage levels. It may be combined with suitable sensors or controls and, where appropriate, other circuit elements such as power transistors, op amps, logic gates, or transducers in a wide variety of industrial, scientific, consumer, and automotive applications. It also can be used in simple measuring instruments, automatic controls, timers, games, and alarms. The only real limits to its range of practical applications are the imagination and skill of the circuit designer. Among the scores of potential gift projects for the TL489C are such items as soil moisture indicators for amateur gardeners; temperature range

indicators; controls and alarms for tropical fish fanciers, budding chemists, chefs, or serious photographers; simple battery or continuity testers for home handypersons and mechanics; visual and audible action toys for the younger set; family games; and simple light organs for audio enthusiasts and musicians. Basic application circuits for the TL489C are shown in Figs. 2 and 3.

Depending on the source of the dc analog voltage, either of the circuits illustrated in Fig. 2 can be used as a coarse indicator of temperature, moisture, battery voltage, audio signal level, continuity (resistance), or control potentiometer position. Referring, first, to Fig. 2A, the TL489C is used to drive standard incandescent lamps. Shunt "keep alive" resistors are connected to ground from each output (Q1 to Q5) to maintain small currents through each lamp while "off," thus avoiding



**B**

INPUT A (NOM)	OUTPUTS				
	Q1	Q2	Q3	Q4	Q5
<≈200 mV	H	H	H	H	H
≈200—≈400 mV	L	H	H	H	H
≈400—≈600 mV	L	L	H	H	H
≈600—≈800 mV	L	L	L	H	H
≈800—≈1000 mV	L	L	L	L	H
>≈1000 mV	L	L	L	L	L

Fig. 1. Block diagram (A) and function table (B) of Texas Instruments' TL489C.



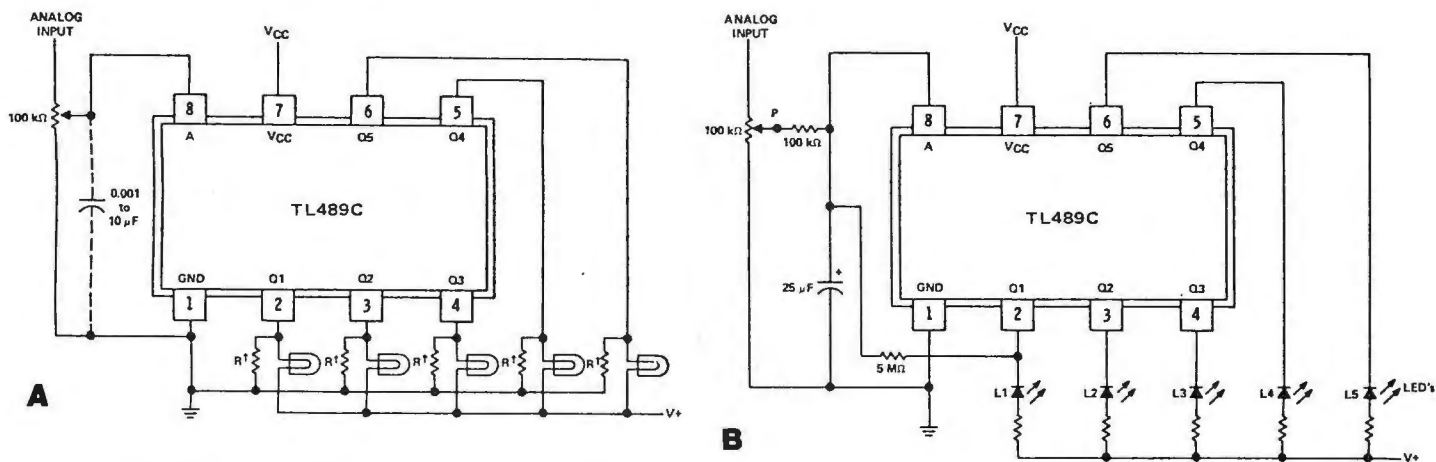


Fig. 2. TL489C level indicators: with incandescent lamps (A); with LEDs (B).

the high inrush currents which occur when voltages are first applied to cold lamp filaments. The resistance values required will depend on the source voltage and on the characteristics of the lamps used.

Owing to the device's high input impedance, an input bypass capacitor may be needed in some applications to prevent false operation by noise signals. As indicated, the value of the bypass may range from as little as 0.001 μF to as much as 10 μF. In the second circuit, Fig. 2B, LED output indicators are used, each with a suitable series resistor to limit its maximum current to safe limits, depending on the source voltage. If desired, different types (and colors) of LEDs may be used for each output, with the corresponding series resistor value adjusted accordingly. The second circuit has another interesting feature. Note that Q1's output is returned to the analog input through a simple RC network. This arrangement causes LED L1 to flash periodically when the input level at point P is below 200 mV.

Either circuit can be used as a temperature indicator by connecting an appropriate thermistor (serving as a sensor) between the analog input terminal of the input potentiometer and a positive dc source voltage. The potentiometer is then used to adjust the resulting instrument to cover the desired range within the limits established by the thermistor's characteristics. As the temperature increases above the minimum preset value, one or more lamps will be turned on.

If a soil moisture indicator is preferred—a nice gift for the amateur gardener—the analog input terminal should be connected to a spike probe, with a second probe connected to a positive dc source through a series current limiting resistor. For consistent test results, the two probes should be mounted in a rigid holder to maintain a fixed separation between them. In use, the spike probe assembly is simply pressed into the soil to be checked. One or more of the lamps will light, depending on the soil's conductivity (relative moisture content). Since soil conductivity will vary with its mineral content (dissolved salts) as well as with moisture, the potentiometer should be used to adjust the unit's overall sensitivity for local conditions.

Replace the moisture tester's fixed probe assembly with flexible lead probes and you have a dandy continuity tester for the home handyman or weekend mechanic. If you prefer a simple battery tester as a gift, simply connect a known good cell between the analog input terminal (positive) of either circuit and ground, adjusting the potentiometer until the first lamp lights. If a standard 1.5-volt cell is used for this calibra-

tion procedure, a 3-volt battery (if good) will light two lamps; 4.5 volts, three lamps; 6 volts, four; and, finally, 7.5 volts or more, all five. For your gift, you may prefer to replace the adjustable potentiometer with a fixed resistor voltage divider, providing extra terminals for checking batteries up to, say, 24 volts or more.

A simple, exciting and delightful toy for the younger set may be created using the same basic circuits. Assemble the circuit in a medium-size cabinet or case and provide a large control knob for the potentiometer. Add a battery power supply and spst on-off switch. Use different colored lamps in each position, replacing at least one with a *Sonalert*. Decorate with suitable decals or painted designs and give each item an appropriate label. One lamp, for example, might be marked ROCKET FUEL, another NUCLEAR REACTOR, another SENSORS, another RED ALERT, and so on, with, perhaps, ATTACK ALARM for the *Sonalert* device, MASTER CONTROL for the potentiometer knob, and MAIN GENERATORS for the power switch. If desired, two or more circuits could be assembled in a single cabinet, with a combination of slide and rotary potentiometers for the "controls." Sparked by their own imagination, most youngsters could spend many happy hours playing "space wars" or other games with such a toy. But make sure you have an ample supply of replacement batteries!

Additional TL489C application circuits suitable for gift projects are illustrated in Fig. 3. The first, Fig. 3A, employs standard logic to develop an output control voltage for an alarm or other purposes if the analog input voltage either drops below or exceeds preestablished limits. Here, only three of the device's five outputs are used. Outputs Q1 and Q3 are low and output Q5 is high (that is, LEDs L1 and L2 are on, L3 is off) as long as the analog input voltage is at its nominal center value but below its maximum limit.

If the input voltage drops a little, but is still above its minimum value, L2 may turn off, but L1 will remain on and there will be no alarm signal for the on gate. Similarly, if the input voltage goes above its nominal center value, but remains below its maximum limit, both L1 and L2 will remain on and L3 off with, again, no alarm output from the OR gate. If the analog input voltage drops below its minimum limit, however, Q1 and Q3 will go high and L1 and L2 will turn off. With Q1 high, though, the OR gate's output will go high to provide the required alarm control signal. On the other hand, if the input voltage exceeds the maximum limit, Q1, Q3 and Q5 all will go low, all three LEDs will be on, and the low at Q5, applied to the OR gate input through an inverter, will cause the OR gate's

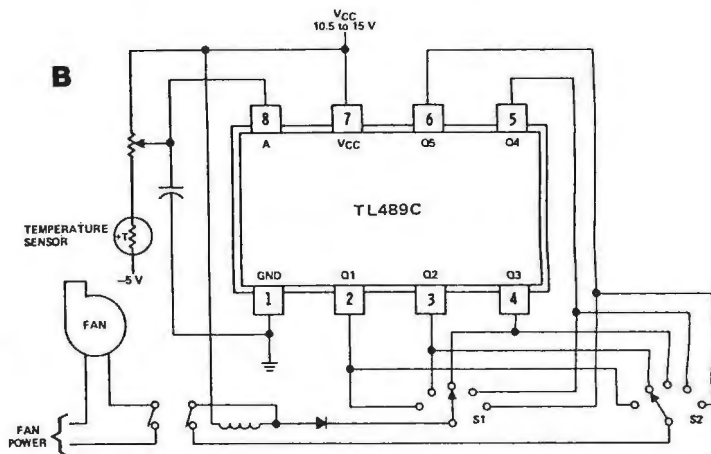
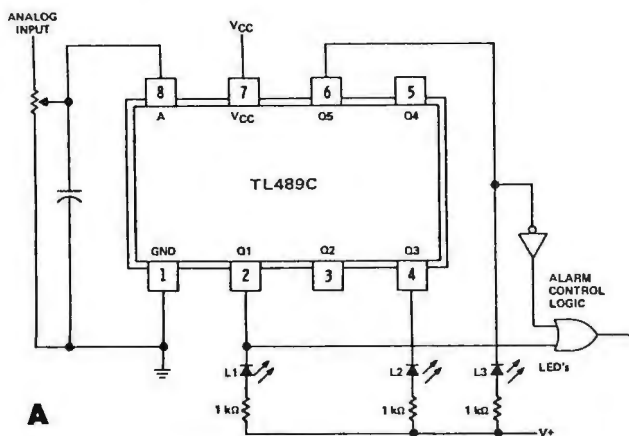


Fig. 3. Three level indicator (A) has alarm logic; control circuit (B) with selectable hysteresis.

output to go high. Again, this will develop a signal to activate the alarm.

Depending on the type of sensor used to develop the analog input voltage, this circuit can be used in burglar and fire alarm systems; in level alarms for water, fuel, or other tanks; in over/under range temperature alarms, in humidity control alarms; in hydraulic or air pressure alarms; or, for that matter, in any system requiring that an alarm or other action be initiated whenever a physical or ambient condition exceeds a pre-determined value range. It may be used in such household projects as temperature alarms for hair dryers, soldering irons, photographic chemical baths, or tropical fish tanks, in humidity alarms for basements or home greenhouses, in

"low-level" warning alarms for household fuel or water tanks, or even in "too dry" alarms for lawns or indoor plants, as well as in dozens of other useful gift projects.

Using a dpst relay instead of digital logic, the circuit shown in Fig. 3B differs from the one just examined. It is basically an electronic limit switch, acting either to switch on or shut off an electrical, electromagnetic, or electromechanical device whenever the analog input voltage is outside the preset, (but adjustable) limits. With the arrangement shown, the circuit responds to temperature changes, switching the blower fan on when the thermistor sensor temperature reaches a given level and off when that temperature drops below a second level. For other applications, the blower fan might be replaced by a pump, heater, lamp, horn, solenoid valve, or other device, and the thermistor by a photo-resistive cell, varistor, humidity detector, semiconductor pressure transducer, or other sensor, depending on the response characteristics needed.

In operation, switch S1 selects the temperature at which the blower fan is turned on, while S2 sets the temperature at which it is switched off. Initially, of course, the relay is open, the blower fan off, and all Q outputs are "high." As the thermistor temperature rises, the analog input voltage increases and Q1, Q2 and Q3 go "low" in successive order. With the switch positions shown, current can flow through the relay coil and isolation diode when Q3 goes low. The relay closes, switching the blower fan on. As the thermistor cools, Q3 will go "high," but relay current continues to flow through the second set of contacts and Q2, which is still "low," and the relay is held closed. Only after the thermistor has cooled enough for Q2 to go "high" does the relay drop out, switching off the blower fan and re-establishing the initial conditions.

The difference between the "turn on" and "turn off" temperatures is the *hysteresis* of the circuit. In terms of the analog input voltage, this can be as little as 10 mV when S1 and S2 are both set to the same "Q" output, to as much as 1000 mV (or 1.0 V) when S1 is set to Q5 and S2 to Q1. The input potentiometer determines the circuit's overall sensitivity and, therefore, the *actual temperature* at which initial operation occurs, regardless of the switch positions (within the limits established by the thermistor characteristics, naturally). Where other types of input sensors are used, hysteresis limits may represent two different pressures, liquid levels, humidity conditions, light intensities, line voltages, sound levels, wind speeds, weights, or other parameters rather than temperature.

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duce the timed interval, a larger value will increase it. For control applications, the lamp load could be replaced by a suitable sensitive relay or, for alarms, by a low-voltage buzzer.

Where wider range and greater versatility are needed, as in a general purpose household timer, the circuit shown in Fig. 4B may be used. Somewhat more complex and hence more expensive to duplicate than the simpler design, this circuit features step-selectable maximum ranges of from three minutes to four hours and is capable of switching (ac) line operated loads. Here, a type CA3094A programmable power switch/amplifier serves as the active device, supplying a gate control signal to a standard Triac. In operation, depressing spst push-button switch *S1* charges timing capacitor *C1* from the dc source through *R5*. The voltage across *C1* (*E1*) is applied to the amplifier's noninverting (+) input and is compared to reference voltage (*E2*), applied to the inverting (-) input through an isolation diode by control *R6*.

As long as *E1* is greater than *E2*, the amplifier supplies a positive gate voltage to the Triac, holding the device in a conducting or on state and permitting current flow through the load. Capacitor *C1* will slowly discharge through the amplifier's input impedance at a rate determined by the amplifier's input bias. This, in turn, is established by bias control resistors *R1* through *R4*. Once *C1* has discharged to the point where *E2* exceeds *E1*, there is no longer a positive gate voltage applied to the Triac. Consequently, this device switches off. The total time during which the Triac supplies current to the load, then, depends on *E2*'s initial value. This, in turn, reflects *R6*'s adjustment and the input bias established by bias resistors (*R1* to *R4*) selected by TIME RANGE SELECTOR switch *S2*. De-

pending on the type of Triac used, the circuit is capable of switching either 120- or 240-V ac loads.

RCA suggests values of 0.51 megohm for *R1*, 5.1 megohms for *R2*, 22 megohms for *R3*, and 44 megohms for *R4* to provide maximum timing periods for each range of 3 minutes, 30 minutes, 2 hours, and 4 hours, respectively. Voltage divider resistors *R5* and *R7* should be 2700-ohm, ½-watt types, gate-current limiting resistor *R8* a 1500-ohm, ½-watt unit, and timing control *R6* a standard 50,000-ohm potentiometer with a linear taper. A type T2302B Triac is recommended for controlling 120-V ac loads; a type T2302D for 240-V applications. The 30-V dc source required for timer circuit operation may be obtained either from batteries or a well-filtered line-operated power supply.

On the other hand, if you're not turned on by timers and are seeking an inexpensive "stocking stuffer" gift for a friend whose interest, as yours, is electronics, you might consider giving the person one of the versatile ICs described in recent columns: perhaps the SN76477 complex sound generator described last October, an 8038 waveform generator or LH0094 multifunction converter, or TL489C analog level detector.

Should you decide on ICs as gifts, be sure to include data sheets and, if available, application notes on the device(s), together with tear sheets of any magazine articles you have featuring the units. If the device is one you've used in projects, you might also include a sketch of your favorite circuit application to add an extra personal touch to your gift.

If you don't feel that you or the recipient of your gift are sufficiently adept at building a project, see the article on page 74 for items the PE editors think would make good gifts. ♦

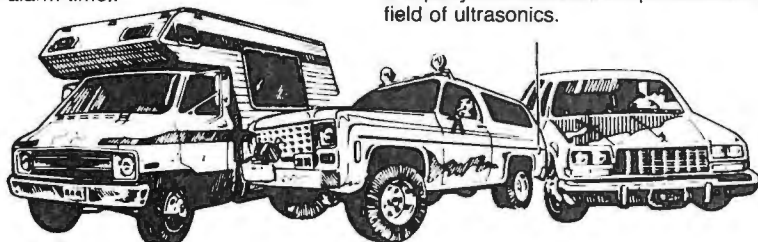
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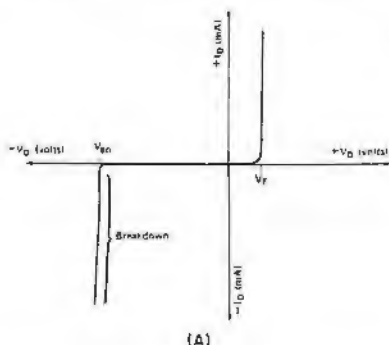


By John McVeigh

## HOW TO FIND PIV

**Q.** I recently bought a batch of surplus diodes, most of them unmarked. How can I determine the PIV of each component without destroying it in the process?—John F. Eldredge, Nashville, TN.

**A.** The V-I characteristic of a silicon diode is shown in the diagram at A. When the diode is forward biased by a voltage equal to  $V_F$ , the diode turns on and conducts heavily. Under reverse bias conditions, current through the diode remains



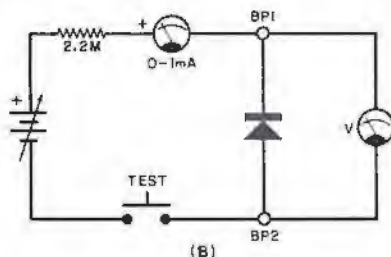
infinitesimal—on the order of nanoamperes—until the breakdown voltage  $V_{BD}$  is reached. At that point, the diode "avalanches" into conduction and will destroy itself unless the current through it is limited by an external factor. A silicon diode is rated by a peak inverse voltage (PIV) that specifies the reverse voltage that the diode can withstand without avalanching. Diodes intended for power rectification applications generally have a PIV rating of greater than 50 volts. Some are rated as high as 1000 volts or more. Silicon switching and signal diodes usually have smaller PIV ratings—on the order of 35 volts or so.

The PIV of a silicon diode can be determined nondestructively by using the circuit shown at B. The variable voltage source applies a controlled reverse bias across the diode. As the TEST button is pressed and the supply voltage is increased, the milliammeter and voltmeter should be monitored. At a certain output voltage, the voltage across the diode will no longer continue to rise and the milliammeter will begin to indicate some current through the diode. The voltage as read on the voltmeter is the  $V_{BD}$  of

the diode. Use the diode under test only in an application in which it will not be subjected to this voltage. Also, leave a safety margin so that the diode will not be operating near the breakdown point.

The variable power supply shown in the schematic should have a peak output somewhat greater than the expected PIV of the diodes. In the case of power rectifiers, this can be as high as 1000 volts. If you want to test such reverse voltages, **EMPLOY CAUTION!** Never connect a diode to binding posts BP1 and BP2 while depressing S1. Take care when wiring the circuit.

If a variable voltage supply with an adequate range of adjustment is not available, you can use a fixed supply and a potentiometer. Connect the poten-



tiometer across the supply with the wiper to the 2.2-megohm resistor. A potentiometer with a maximum resistance of 50,000 ohms or more will be suitable. Determine the power rating of the potentiometer using the equation  $P=V^2/R$  where  $R$  is its resistance and  $V$  is the maximum output voltage of the supply. Again, take care if you are using an HV supply. Employ only a pushbutton switch or spring-loaded toggle switch (normally open) for S1 that is rated to withstand the peak output of the supply.

## DETERMINING COAX LOSSES

**Q.** I am planning to install a master television antenna system in my home. One problem—I can't find out how to determine coaxial cable attenuation. Is there a formula to determine attenuation per 100 feet (30.5 m) of RG-59/U cable, or any other type of coax?—Charles H. Lake, Jr., Independence, MO.

**A.** Transmission lines can be described by so-called distributed constants:  $R$ ,

the resistance of the conductors in ohms per foot or meter;  $L$ , inductance per unit length;  $G$ , the conductivity of the insulating dielectric in ohms per unit length; and  $C$ , the capacitance between the conductors in microfarads per unit length. Each type of line has its own propagation constant  $\gamma$  equal to:  $(R+jL)(G+jC)$ . The propagation constant is also expressed as  $\gamma = \alpha + j\beta$ , where  $\alpha$  is an attenuation factor in nepers per unit length (one neper is 0.115 decibels) and  $\beta$  is a phase factor in radians per unit length. We can approximate  $\alpha$  as  $\frac{1}{2}(RVC/L + GVL/C)$  and  $\beta$  as  $\omega LC$  where  $\omega$  is the angular frequency in radians/second. Thus, if we know the four distributed constants, we can determine the attenuation and phase-shift factors of the line.

However, measuring the distributed constants requires test equipment that most of us don't have. Fortunately, the results of such measurements are readily available. On page 24-41 of Reference Data for Radio Engineers (published by Howard W. Sams & Co.) a comprehensive plot of attenuation of various types of cables in dB per 100' is shown. A similar graph appears on page 93 of The ARRL Antenna Book (published by the American Radio Relay League). The graphs are valid for cable in good condition, cable that has not deteriorated from the effects of the environment. If you don't have either of these books, you'll probably find a copy in any engineering school's library.

Cable losses can be determined empirically in the following manner. Terminate one end of the cable with a carbon resistor whose resistance equals the characteristic impedance of cable. Then, connect a signal generator whose source impedance equals the characteristic impedance of the line to the other end. Adjust the generator so that it produces a convenient output level as measured on an oscilloscope or r-f voltmeter at the frequency of interest.

The vertical bandwidth of the oscilloscope or the response of the voltmeter must be such that the instrument is calibrated at the frequency of measurement. Also, the instrument must be coupled to the line so that it disturbs the conditions on it as little as possible.

Measure the signal voltage at the output of the signal generator and that at the matched termination. The attenuation exhibited by the transmission can then be determined using the formula:

$$A \text{ (dB)} = 20 \log (V_{IN}/V_{OUT}).$$

Have a problem or question on circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016. Though all letters can't be answered individually, those with wide interest will be published.



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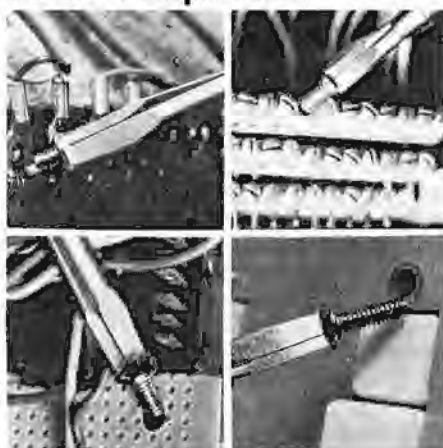
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# Experimenter's Corner

By Forrest M. Mims

## THE 74154 DEMULTIPLEXER

**A** MULTIPLEXER, as you'll recall from last month's column, has a set of address inputs that selects one of several data inputs. The logic level at the selected input is then routed to the chip's single output pin. A *demultiplexer*,

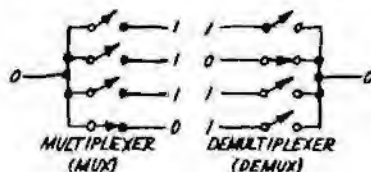


Fig. 1. Comparing multiplexer and demultiplexer.

as you might expect, performs the opposite function. A set of address inputs selects one of several *outputs*. The binary status of a single input is then steered to the selected output.

Figure 1 will help you visualize the essential difference between a multiplexer (MUX) and a demultiplexer (DEMUX).

**Simple 1-of-2 Demultiplexer.** Figure 2 shows a simple single-input DEMUX with two outputs and one output select (address) line. The circuit is called a 1-of-2 DEMUX since the logic state of the single input is steered to one of the two outputs at any given time according

to the status of the output select line. The output select line serves the same function as the data select input of a MUX. The logic level at the output select line is called an *address* because each possible output select logic state, in this case 0 and 1, selects one and only one output.

Referring to Fig. 2, assume the data input is low (logic 0). When the address at the output select line is logic 0, NAND gate A is selected and the logic 0 at the data input appears at the A output. The B output remains at logic 1. When the output select address is logic 1, NAND gate B is selected and the logic 0 at the data input is steered to the B output. The outputs of both NAND gates will be high no matter which is selected by the output select address.

Try proving this explanation for yourself by following all possible input and address combinations through the circuit. If you need help, Fig. 2 also shows the truth tables for the 1-of-2 DEMUX as well as those of the gates and inverters of which it is composed.

**Using Demultiplexers as Decoders.** By definition, a logic decoder con-

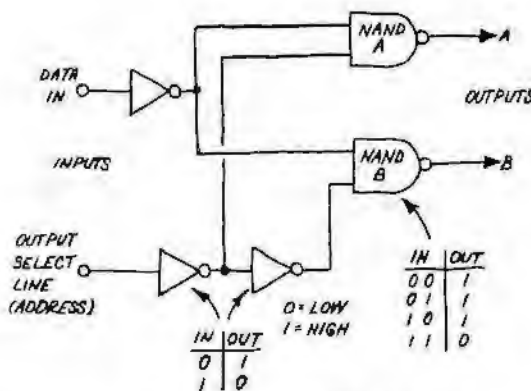


Fig. 2. Logic diagram and truth tables for a simple 1-of-2 demultiplexer.

DATA IN	ADDRESS	OUTPUT A	OUTPUT B
0	0	0	1
0	1	1	0
1	0	1	1
1	1	1	1



verts a binary input into some other number system, often octal, decimal or hexadecimal. A demultiplexer can be easily transformed into a decoder by placing its data input at the low state. This will cause the output selected by the input address to be low while all other outputs are high. If the DEMUX has four address lines and sixteen outputs, applying a sequential binary count (0000, 0001, 0010...1111) to the address lines will cause the respective outputs to sequentially drop to logic 0 one at a time.

For a better understanding of how a DEMUX can be used as a decoder, mentally assign the data input in Fig. 2 to ground (low). Then label outputs A and B with the *digits* (not bits) 0 and 1. If the outputs are connected to LEDs, the 0 digit LED will glow when the address, which has now become the binary input, is logic 0 and the 1 digit LED will glow when the binary input is logic 1. Demultiplexers have many applications when used as decoders.

**Advanced Demultiplexers.** You can easily breadboard a working version

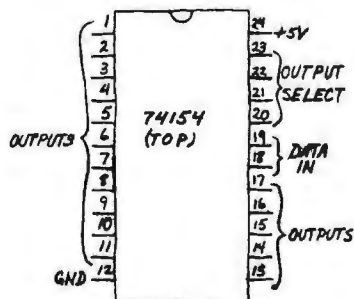


Fig. 3. Pin outline of the 74154 demultiplexer.

of the 1-of-2 DEMUX in Fig. 2. This circuit, however, has relatively limited utility. Fortunately, a number of more versatile demultiplexers are readily available. These include the 74139, 74155 and 74156 dual 1-of-4 and the 74154 1-of-16 demultiplexers. CMOS demultiplexers are also available.

**The 74154 Demultiplexer/Decoder.** Figure 3 is the pin outline of the 74154 DEMUX. This chip has four address inputs and sixteen outputs. Two data inputs, G1 and G2, are provided. When both data inputs are at logic 0, the circuit functions as a binary-to-hexadecimal, or, as it is also known, a 4-line-to-16-line decoder. Demultiplexing is performed when one input is kept at logic 0.

(Continued on page 87)

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# PROJECT OF THE MONTH

## ADDING RAM TO A HEX KEYPAD ENCODER

The last Project of the Month described a hexadecimal keypad encoder designed around a 74150 1-of-16 multiplexer. That encoder can be used to load 4-bit nibbles onto a 4-bit microcomputer bus and to write data into a 4-bit RAM such as the 7489. The 7489 TTL chip was the subject of the December 1977 and January 1978 installments of Experimenter's Corner.

As this month's project, we will add a 7489 to the keypad encoder. This results in a circuit with many applications, particularly if a clock and counter is included to enable the data stored in the RAM to be read out a nibble at a time at an adjustable rate. The circuit can be used as is to store hex numbers such as microprocessor instructions and data, or it can be used as a simple controller.

As a controller, the circuit can be connected to a D/A converter such as the one described in the August 1978 installment of Experimenter's Corner to generate programmable waveforms or even brief, 16-note electronic tunes. The D/A converter will also permit the speed of a motor or the brightness of a lamp to be controlled.

The schematic diagram shows a RAM

plus clock and counter you can add to the keypad encoder described last month. If you duplicated the prototype, there should be just enough space on the circuit board for the additional circuitry.

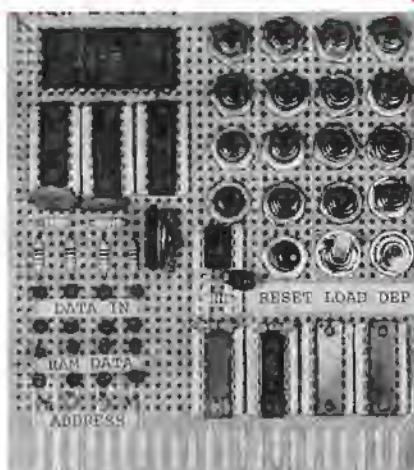
Operation of the RAM and its associated circuits is as follows. The 74173 data storage register in the keypad encoder is connected directly to the inputs of the 7489 RAM. When S1 is in the LOAD position, the RAM deposits the nibble stored in the 74173 into the RAM location corresponding to the address selected by the 74193.

Normally, the data loading process is begun at RAM address 0000 by opening normally closed pushbutton S2. To load the first nibble into the RAM, S3 is toggled to its DEPOSIT position and then back to READY. This delivers a single, bounce-free pulse to the 74193 counter and advances the counter to the next address (0001). The nibble in the 74173 is then safely loaded in RAM location 0000. Incidentally, the bounce-free operation of S3 is provided by an RS flip-flop made from one half of a 7400 quad NAND gate.

The RAM is now ready to receive a second nibble. If the same nibble is to be loaded in the second RAM slot as was in the first, S3 is toggled again. Otherwise, a new key on the hex keyboard is pressed and S3 toggled to deposit the new nibble at RAM address 0001 and increment the counter to address 0010.

This data loading process continues until all sixteen address slots in the 7489 are occupied. After the final nibble is selected, however, the DEPOSIT switch is not toggled. Rather, S1 is switched to READY. This preserves the data in address 1111 and prevents the nibble in address 0000 from being inadvertently overwritten by the data in address 1111.

When S1 is switched from LOAD to READY, clock pulses from the 555 are delivered to the 74193 and the circuit auto-



matically flashes out the data stored in the RAM a nibble at a time at a rate determined by trimmer R1.

The 7404 hex inverter between the 7489 and the LEDs connected to the RAM outputs is required to invert the RAM's data back to its original form. This is so because the RAM stores the complement of data at its input. (You can eliminate the 7404 if you reverse the hex numbering sequence on the keyboard switches.)

The photograph shows the prototype hex keypad encoder plus data storage circuit. As you can see, there's just enough room for all the components on the circuit board.

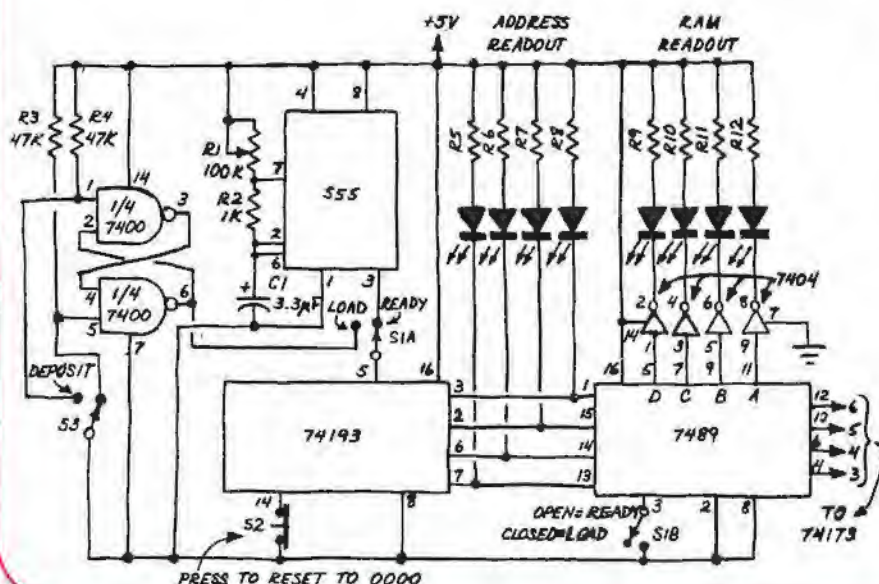
Be sure you have made no wiring errors before connecting a 5-volt supply to the completed circuit. Then press pushbutton S2 to reset the counter. All the address LEDs should turn on to indicate 0000.

Test the circuit by loading each RAM address with its hex counterpart (press 0 for address 0000, 1 for 0001, etc.). Remember to toggle S3 to deposit each keyboard entry *except the final one*. After the final entry, switch S2 from LOAD to READY and watch the address and RAM LED readouts. They should flash an identical 0000-1111 sequence as the counter cycles the RAM through each of its storage slots. Adjust R1 to obtain a reasonably slow clock rate if necessary.

You can manually single-step the RAM through each of its addresses by using two separate switches for S1. The switch at pin 5 of the 74193 is toggled to LOAD while the switch at pin 3 of the 7489 is left at READY. Switch S3 is then toggled to advance the RAM to successive addresses.

After the data loader is running properly, consider connecting the RAM outputs to a D/A converter and using the circuit as a controller. You will find that the data storage hex keyboard will do many things a microprocessor does but with less trouble.

You can also connect the RAM outputs to the address inputs of a 74154 decoder whose outputs are connected to LEDs, relays or tone generators. This will provide a very versatile control capability.





(Continued from page 85)

ic 0 and the other used as a data input. When the single data input is at logic 0, the output selected by the address is at

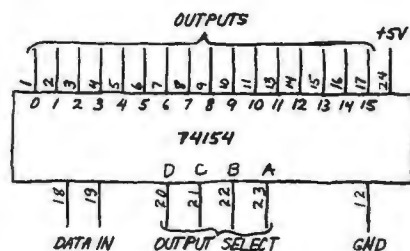


Fig. 4. How pins of the 74154 are organized.

logic 0 and all other outputs are at logic 1. When the data input is at logic 1, all outputs, including the selected one, are logic 1.

Operation of the 74154 is more easily understood by referring to Fig. 4. This figure reveals the 74154 DEMUX to be a mirror image of the 74150 MUX which was the subject of last month's Experimenter's Corner.

#### A Demonstration Demultiplexer.

Figure 5 is a circuit you can make to demonstrate the operation of the 74154 as a DEMUX. The circuit has no practical applications as shown, but they can be implemented by replacing the data input and/or address switches with logic signals from other circuits.

#### Binary-to-Hexadecimal Decoder.

A somewhat more practical application

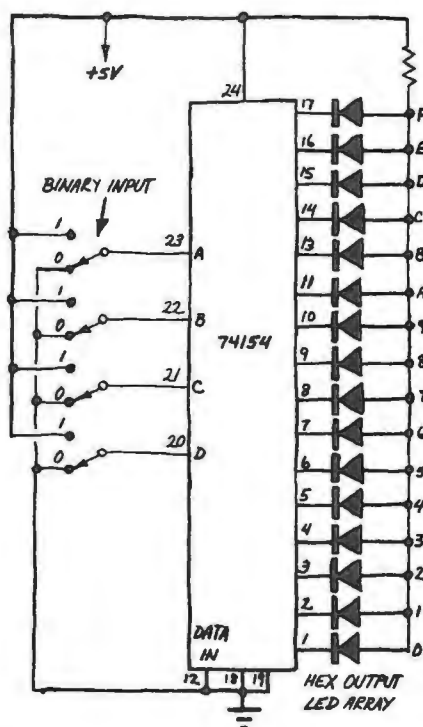


Fig. 6. A 74154 binary-to-hexadecimal decoder.

for the 74154 is shown in Fig. 6. Both inputs of the 74154 are at logic 0 (grounded) to exploit the decoder capabilities of the chip. In operation, a 4-bit nibble at the address inputs is decoded by the 74154. One of the sixteen outputs from the 74154 then goes low while all the others stay high. The LED connected to the low output glows to indicate the de-

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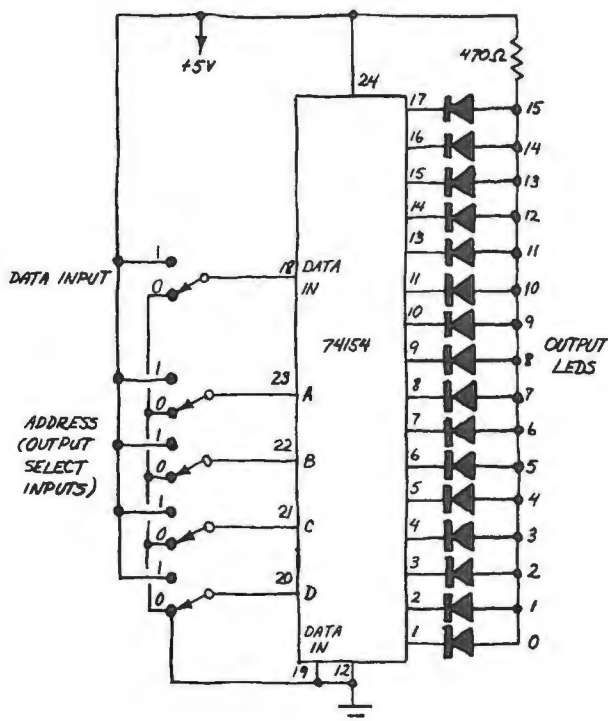
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Fig. 5. A 74154 demultiplexer demonstrator circuit.



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coded number. Although the circuit is a binary-to-hexadecimal decoder, it can convert a 4-bit binary number into its counterpart in any other number system by properly labeling the output LEDs.

**Digital Sequencer.** Figure 7 shows a circuit which has numerous applications, a digital sequencer. In operation, the 555 clock delivers a train of pulses to the input of a 74193 4-bit counter. The counter outputs are applied to the address inputs of a 74154, and its 16 outputs are sequentially strobed from high to low.

In this circuit, the 74154 is operated as a 4-line-to-16-line decoder, but it can

pulse every 0.05 seconds (50 milliseconds) to use the circuit as a reaction tester. Connect an spst toggle switch and a normally closed pushbutton switch in series between pin 3 of the 555 and pin 5 of the 74193. Have a friend close the toggle switch after a random interval to start the test. As soon as the first LED glows, press the pushbutton to stop the clock. The number of the lit LED indicates your reaction time.

How can you calibrate the circuit to indicate 50 milliseconds per LED? One way is to use an oscilloscope with a calibrated horizontal timebase. Alternatively, use a digital stopwatch and adjust *R1*

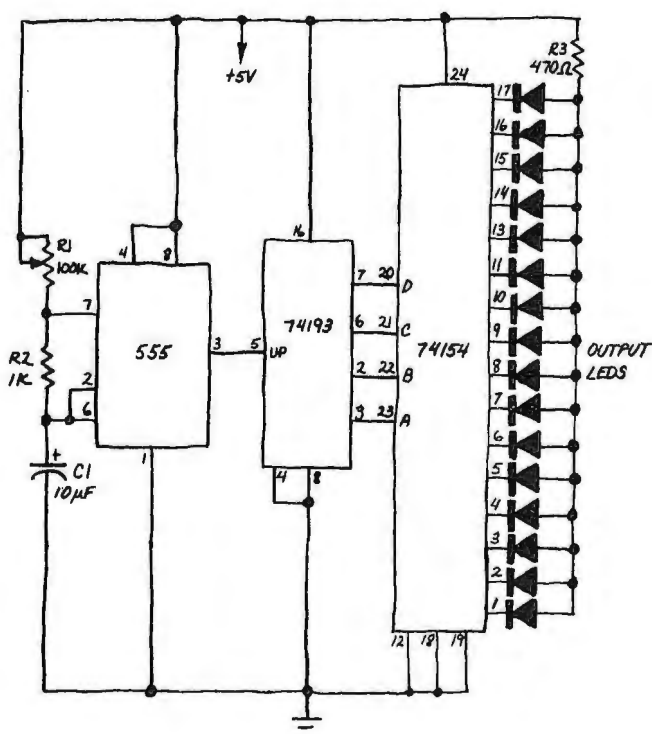


Fig. 7. A 1-of-16 sequencer circuit.

also be used as a DEMUX by disconnecting one of the two data input lines (pins 18 and 19) from ground and strobing it with a logic 0 signal when an output is desired. In either case, the outputs of the 74154 can be used to drive LEDs, relays, transistors or SCRs. They can also be connected to other logic circuits or even other DEMUX chips to provide expanded decoding capability.

If the 555 clock is calibrated to emit pulses at known intervals, the sequencer can be used as a simple clock. Applications include darkroom timing when the clock operates at 1 Hz and timing phone calls when the clock emits one pulse per minute.

Adjust the clock so that it generates a

pulse every 0.8 seconds (50 milliseconds) to use the circuit as a reaction tester. Connect an spst toggle switch and a normally closed pushbutton switch in series between pin 3 of the 555 and pin 5 of the 74193. Have a friend close the toggle switch after a random interval to start the test. As soon as the first LED glows, press the pushbutton to stop the clock. The number of the lit LED indicates your reaction time.

**Programmable Sequencer.** The 74193 counter has a very useful pin designated CLEAR. Normally this pin is held low by connecting it to ground. If CLEAR goes high, the counter immediately re-sets or clears to 0000.

This feature makes possible a programmable digital sequencer. Suppose you want to sequence through only the first ten of the sixteen outputs of the 74154. Simply connect the eleventh output to the CLEAR pin of the 74193 through an inverter. As soon as the elev-



enth output goes low, the CLEAR input of the 74193 goes high and resets the counter. The cycle then begins anew at address 0000.

**Reader Letters.** I would like to thank those of you who have written expressing interest in this column. Your comments and suggestions are often taken into consideration when topics for future columns are selected. If you would like to suggest a topic for the future installment or comment upon a past one, I would appreciate hearing from you. Address your card or letter to Experimenter's Corner in care of POPULAR ELECTRONICS. Unfortunately the volume of correspondence received far exceeds the time available for composing replies. I will, however, attempt to provide a *brief* response to readers who include a stamped, self-addressed envelope.

Some readers have requested schematic diagrams for various circuits they wish to build. If the requested circuit appears to have the potential of wide reader appeal, I will consider developing it for inclusion in a future installment of Experimenter's Corner. Otherwise, time does not permit custom circuit design for individual readers.

Thanks also to the dozen or so readers who caught the major error in Figure 4 of the July 1978 Experimenter's Corner. As shown, the spdt input switches will cause a dead short across the 9-volt battery when they are placed in the 0 position. The error can be remedied by connecting the center pole of each switch to the four input resistors. Also, the straight line plotted on the graph in Figure 5 should be a stepped function.

On a related subject, I want to reply to a letter from Allan P. Saadus that appeared in the August 1978 issue of POPULAR ELECTRONICS. His letter described a way to simplify the pseudo-random number generator described in the January 1978 installment of this column.

While Allan's circuit will work, it is no longer a pseudo-random number generator. Instead, it is merely a sequential number generator or, in other words, a RAM used as a counter. The same function can be achieved with a clock and counter *without* the RAM.

Allan suggests that eliminating one of the clock plus counter circuits will reduce the parts count. As the text explained, however, the additional clock plus counter provides the very rapid sequence of numbers from which one is randomly selected each time the RAM is advanced to a new address. ◇

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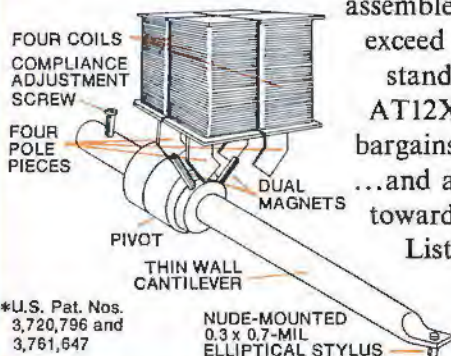
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# Computer Bits

By Leslie Solomon

## ENHANCED GRAPHICS

**N**OT TOO long ago, when video plug-in boards for computers came along, someone discovered that novel and interesting graphics could be created using non-alphanumeric control symbols that are present in some character generators. A classic example is the VDM-1 playing Target or TREK80.

There have been many other video displays since then, each using its own special control characters for graphics. Finally, along came a computer (Pet) that had a set of dedicated graphic symbols available at the user's fingertips.

So far, however, these forms of graphics have been limited to the symbols that the chip or computer manufacturer decided to include.

Recently, Exidy Inc. (969 Maude Ave., Sunnyvale, CA 94086) introduced its Sorcerer computer (\$895), which features up to 128 user-defined graphic symbols as well as 128 upper- and lower-case ASCII characters, and 64 Pet-like graphic symbols. This 64-character by 30-line display system also uses the ubiquitous S-100 bus, and has a unique set of one-stroke BASIC commands where certain keys produce BASIC instructions (FOR, NEXT, REM, STOP, etc.) for one keystroke.

The feature of the computer that intrigued us was the user-defined graphic symbols. Such an approach allows us to use certain symbols currently not available: a tilde, an umlaut, special math and APL symbols, italics and even script! It can also be used to create certain foreign-language symbols for Arabic, Hebrew, Greek, or other languages not written in "English" symbols. We can even create strange logos, swirls, whirls or stripes for special displays. In fact, we can create any symbol we desire.

Exidy provides two approaches to the creation of special symbols. In one mode, each special character is stored in eight successive memory locations between FE00 and FFFF (where the number key symbols are stored).

To create a symbol, an 8 x 8 graph is used in conjunction with a pencil to dark-

en the blocks not required for that symbol. Each row of 8 blocks is coded as a hex digit with a dark space being a "0" and a white space a "1". Each row is then ENTERED via the monitor at the desired key address. Now, when you hit that key, the symbol appears.

The second approach uses an ingenious BASIC program that, when RUN, displays an 8 x 8 array of boxes on the screen with the cursor in the top left-hand box. After selecting the number key in which you wish the character to appear, the cursor-positioning keys are used, with a graphics key depressed, to insert a white box at the desired location to form the wanted character. The space bar is used to erase any unwanted square. After RETURN is hit, the program then POKES around in the memory to insert the 1's and 0's needed to form the special symbol.

With a little practice, one can create italics, script, or any symbol desired.

**Double Disk.** If you use one of the small (5¼") diskettes, then you should know that there is a relatively easy way to double the storage area of the diskette. Square-1 (614 18th Ave., Menlo Park, CA 94025; Tel: 415-325-4209) is making available its Flippy Disk kit for \$9.95. It contains a hand punch, a metal template, a pencil and a set of instructions on how to use the other side of your present diskettes. This kit will work with any diskette whose "other side" is coated and burnished (shining surface). We had occasion to try this kit with some of our diskettes and found the procedure easy to follow, and very satisfying as we wound up with double our disk space. We did have one disk that did not have the required second surface.

**S-50 Parallel Interface.** Available from F&D Associates (1210 Todd Rd., New Plymouth, OH 45654), the VPI-1 Versatile Parallel Interface is a 4-port I/O board for the S-50 bus. This board can support two MC6820 PIA, two



MC6522, or one of each to give a total of 40 I/O lines, 36 of which can be input or output, and four that are input only. These lines are arranged in four groups with 8 I/O lines, one I/O handshake, and one input handshake. The lines go to selected drivers and buffers that can drive up to 300 mA at up to 80 volts. Discrete transistors, SCR's, or triac's may be used. Space is provided for clamping and transient-suppression diodes. With the 6522 you also get two programmable timers that can be used for a variety of functions. The VPI-1 can replace two SWTP MP-L boards in most applications. The bare boards are \$32.50 each plus \$2.50 shipping/handling charge. Documentation only is \$5 pp. Ohio residents please add 4% sales tax.

**EPROM Erasing.** A couple of new ultraviolet lamp EPROM erasers are available from Spectronics Corp. (956 Brush Hollow Rd., P.O. Box 483, Westbury, NY 11590; Tel: 516-333-4840). The Model PE-14 (\$59.50) will support up to six EPROM chips at a time and will erase them in as little as 14 minutes. The UV lamp fits into a special shielded reflector and is kept at a constant distance from the EPROM's. A safety interlock prevents the unit from operating when the tray is not fully inserted. A conductive foam pad holds the chips in place. The PE-24, at \$104.50 is similar to the PE-14 but holds up to nine EPROM's and can erase them in less than 12 minutes. A 60-minute timer is also included for automatic shutoff.

**Music Boards.** One of the original computer music system manufacturers, Newtech Computer Systems, Inc. (230 Clinton St., Brooklyn, NY 11201; Tel: 212-625-6220) recently announced its Plus Americana music software that works with either its S-100 bus Model-6, or its SWTP-compatible Model-68 plug-in boards. These boards are available for \$59.95 (assembled and tested) at your local computer store. Supplied on an MD-1NS diskette for the North Star system or an MD-1SW disk for the SWTP system (\$19.95 each), the programs feature a dozen pre-recorded melodies, including five having two voices. The diskettes also feature Jukebox, a BASIC program that allows choice of any of the musical selections. Although the two music boards come with their own small speakers, we recommend that the audio output be fed to a conventional audio system to take advantage of the improved sound. ◇



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No additional hardware is required to connect ELF II to your TV's video input. If you prefer to connect ELF II to your antenna terminals instead, simply use a low cost RF modulator (to order one, see coupon below).

ELF II's 5-card expansion bus (connectors not included) allows you to expand ELF II as your needs for power grows. If you're an engineer or hobbyist, you can also use ELF II as a counter, alarm, lock, thermostat, timer or telephone dialer, or for countless other applications.

### ELF II Explodes Into A Giant!

Thanks to ongoing work by RCA and Metronics, ELF II add-ons are among the most advanced anywhere. Plug in the **GIANT BOARD™** and you can record and play back programs, edit and debug programs, communicate with remote devices and make things happen in the outside world. Add **Kluge Board** to get ELF II to solve special problems such as operating a more complex alarm system or controlling a printing press. Add **4k RAM** board and you can write longer programs, store more information and solve more sophisticated problems.

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Netronics will soon be introducing the ELF II Color Graphics & Music System—more breakthroughs that ELF II owners will be the first to enjoy!

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Like all computers, ELF II understands only "machine language"—the language computers use to talk to each other. But, to make life easier for you, we've developed an ELF II **Tiny BASIC**. It talks to ELF II in machine language for you so that you can program ELF II with simple words that can be typed out on a keyboard such as PRINT, RUN and LOAD.

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In fact, not only will you be able to use a personal computer creatively, you'll also be able to read magazines such as BYTE...INTERFACE AGE...POPULAR ELECTRONICS and PERSONAL COMPUTING and understand the articles.

If you work with large computers, ELF II and our *short Course* will help you to understand what makes them tick.

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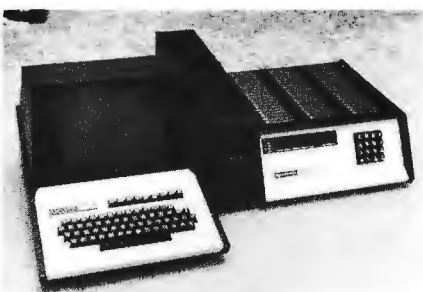
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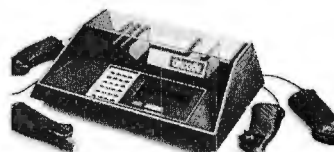
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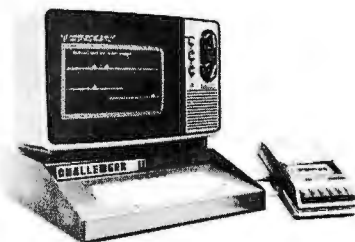
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**6502 DOS Software.** KVOS is a miniaturized operating system for use with 6502 systems using the TIM monitor ROM, with the S.D. Sales "Versafloppy" or the CGRS Floppy I/O; it can be used with CGRS S-100/6502 systems or with other 6502 systems via the CGRS S-100 adapter card. Two versions are available: KVOS1T, which adds file-name disk commands to the TIM monitor, is available as one 2708 ROM and a diskette, at \$40. KVOS2T, with the addition of a disassembler and dynamic program tracing, is supplied on two 2708s plus diskette, at \$65. CGRS Microtech, Box 368, Southampton, PA 18966.

**Z80 APL Interpreter** APL is now available for Z80 based systems using Digital Group or CP/M operating systems. The APL/Z80 interpreter includes nearly all primitive APL functions and operators. Primitives not present can be implemented as defined APL functions, according to the system's developer. Purchasers must sign and return an end user software license and nondisclosure agreement permitting use on one computer system only. \$300. Vanguard Systems Corp., 6812 San Pedro, San Antonio, TX 78216

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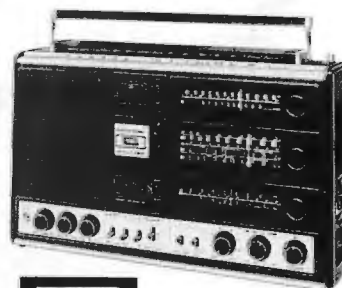
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TIME <sup>1</sup> EST	TIME UTC/GMT	STATION	QUAL. <sup>2</sup>	FREQUENCIES, kHz <sup>3</sup>
4:00-4:15 a.m.	0900-0915	BBC	A	11955, 9640, 9510, 7150, 6195
4:00-4:15 a.m.	0900-0915	R. Japan*	B	9505
4:00-5:00 a.m.	0800-1000	R. Australia	C	9670, 9540
4:00-6:00 a.m.	0900-1100	R. Oman	D	11890
5:00-5:05 a.m.	1000-1005	UN Radio	A	9565, 5955 (Tue-Sat)
5:00-5:30 a.m.	1000-1030	R. Japan	B	9505
5:00-5:30 a.m.	1000-1030	V. of Vietnam	C	12035, 10040
5:00-6:00 a.m.	1000-1100	KGEI, San Francisco	A	5980 (frequent changes)
5:00-sunrise	1000-	R. Australia	B	5995
5:30-6:30 a.m.	1030-1130	Sri Lanka Br. Corp.	C	17850, 15120, 11835 (not all Eng.)
5:55-6:55 a.m.	1055-1155	R. Thailand	C	11905, 9665
6:00-6:15 a.m.	1100-1115	R. Japan	B	9505
6:00-6:56 a.m.	1100-1156	R. RSA	C	21535, 25790
6:00-7:35 a.m.	1100-1235	TWR-Bonaire	A	11815 (Sat, Sun-1220)
6:00-7:50 a.m.	1100-1250	R. Pyongyang	C	11535, 9977
6:00-8:00 a.m.	1100-1300	R. Australia	A	9580
6:00-8:30 a.m.	1100-1330	BBC	A-B	11775, 6195, 5990
6:00-9:00 a.m.	1100-1400	4VEH, Haiti	B	11835, 9770
6:00-9:00 a.m.	1100-1400	VOA	A	9730, 9565 (to 1430), 5955, 6185 (to 1430)
6:30-9:00 a.m.	1130-1400	CBC Northern Service	B	9625, 6065 (not all Eng.)
7:00-7:15 a.m.	1200-1215	R. Japan	B	9505
7:00-7:30 a.m.	1200-1230	Israel Radio	C	25605, 21495, 17685, 15530, 15405, 11655
7:00-7:30 a.m.	1200-1230	R. Tashkent	C	9600, 9540, 6025, 5975
7:00-7:45 a.m.	1200-1245	V. of Germany	B	21600, 17765, 15410
7:00-7:45 a.m.	1200-1245	R. Berlin International	C	21540, 15320, 15125
7:00-7:55 a.m.	1200-1255	R. Peking	C	11685
7:00-9:00 a.m.	1200-1400	AFRTS-Washington	A	15430, 15330, 9700, 6095
7:00-11:30 a.m.	1200-1630	HCJB, Ecuador	A	15115, 11745
7:15-7:30 a.m.	1215-1230	V. of Greece	B	17830, 15345, 11730
7:20-7:50 a.m.	1220-1250	R. Ulan Bator, Mongolia	D	12070, 6383 (not Sun)
7:30-7:55 a.m.	1230-1255	Austrian R.	C	17725 (frequent changes)
7:30-8:00 a.m.	1230-1300	R. Bangladesh	D	21683, 15520 (both vary)
7:30-8:00 a.m.	1230-1300	R. Sweden	C	21700
7:30-8:20 a.m.	1230-1320	TWR-Bonaire	A	15255
7:30-9:20 a.m.	1230-1420	"	"	"
8:00-8:15 a.m.	1300-1315	R. Japan	B	9505
8:00-8:30 a.m.	1300-1330	R. Finland	C	15210
8:00-10:50 a.m.	1300-1550	R. RSA	B	25790, 21535, 15220, 11900
8:00-11:00 a.m.	1300-1600	HCJB, Ecuador	B	17890
8:15-8:45 a.m.	1315-1345	Swiss R. International	C	21630, 21545-SSB, 21520, 15350, 17790
8:30-9:30 a.m.	1330-1430	R. Finland	C	15105 (Sun, only)
8:30-10:00 a.m.	1330-1500	All India R.	C	15335, 11810
8:30-11:00 a.m.	1330-1600	BBC	B-C	21710, 17705, 15400 (from 1430), 15070
9:00-9:30 a.m.	1400-1430	R. Japan	B	9505
9:00-9:30 a.m.	1400-1430	R. Sweden	B	21505
9:00-9:30 a.m.	1400-1430	R. Norway	B	17840, 15175 (Sun only)
9:00-9:30 a.m.	1400-1430	V. Rev. Party, N. Korea	D	4557, 4120
9:00-9:30 a.m.	1400-1430	R. Afghanistan	D	4775
9:00-9:30 a.m.	1400-1430	R. Tashkent	C	9600, 9540, 6025, 5975
9:00-9:45 a.m.	1400-1445	R. Berlin International	B	21540, 15125
9:00-10:00 a.m.	1400-1500	V. of Indonesia	C	11789
9:00-10:00 a.m.	1400-1500	R. Veritas (Philippines)	C	11810
9:00 a.m.-7:00 p.m.	1400-2400	CBC Northern Service	B-C	11720, 9625 (not all Eng.)
9:30-10:00 a.m.	1430-1500	R. Finland	B	15210
9:30 a.m.-5:00 p.m.	1430-2200	UN Radio	A	21670, 15410 (also French; when in session)
10:00-10:15 a.m.	1500-1515	R. Japan	C	9505
10:00-11:00 a.m.	1500-1600	V. of Rev. Ethiopia	D	9615 (frequent changes)
10:00-11:00 a.m.	1500-1600	BBC	B	17840, 11775 (Sat, Sun)
10:15-10:30 a.m.	1515-1530	V. of Greece	B	17830, 15345, 11730
10:30-11:00 a.m.	1530-1600	Swiss R. International	B	21570
10:30-11:30 a.m.	1530-1630	V. of Vietnam	C	12035, 10040
10:45-11:00 a.m.	1545-1600	R. Canada International	A	17820, 15325 (Mon-Fri only)
11:00-11:15 a.m.	1600-1615	R. Japan	C	9505
11:00-11:15 a.m.	1600-1615	R. Pakistan	C	17830, 15520, 11672
11:00-11:30 a.m.	1600-1630	R. Korea	C	9740, 9640, 7150



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11:00-11:30 a.m.	1600-1630	R. Norway	B	17715, 15175 (Sun only)
11:00-12:00 a.m.	1600-1700	VDA	A	26040, 21485, 17870, 17710
11:00 a.m.-12:09 p.m.	1600-1709	BBC	B	17840, 11775 (Sat, Sun-1745)
-11:30 a.m.	-1630	R. Singapore	C	11940 (fade-in time varies)
11:45-12:00 a.m.	1645-1700	R. Canada International	A	17820, 15325
12:00-12:15 p.m.	1700-1715	R. Japan	C	9505
12:00-1:00 p.m.	1700-1800	HCJB, Ecuador	B	21480, 17745, 15295
12:00-2:00 p.m.	1700-1900	VDA	A	26040, 21590, 21485, 17870, 17785, 17710
12:05-12:55 p.m.	1705-1755	R. France International	B	15425, 15360, 15300, 15210
12:45-3:00 p.m.	1745-2000	BBC	C	15400, 12095 (11820 from 8200)
1:00-1:15 p.m.	1800-1815	R. Japan	B	9505
1:00-1:30 p.m.	1800-1830	R. Canada International	B	17760, 15260
1:00-1:30 p.m.	1800-1830	R. Norway	C	11895 (Sun only)
1:00-1:30 p.m.	1800-1830	R. Korea	C	9720
1:00-2:00 p.m.	1800-1900	R. Algiers	C	9510
1:00-2:30 p.m.	1800-1930	V. of Nigeria	C	15120, 11770
1:00-3:00 p.m.	1800-2000	AFRTS-Washington	A	17765, 15430, 15330, 11805, 11790
1:00-4:00 p.m.	1800-2100	R. Kuwait	C	12085
1:15-1:45 p.m.	1815-1845	Swiss R. International	C	15305
1:15-2:00 p.m.	1815-1900	V. of Revolution, Guinea	C	15310 (varies) (Sun only)
1:30-1:35 p.m.	1830-1835	UN Radio	A	21670, 19505-SSB, 15410 (Mon-Fri)
1:45-2:45 p.m.	1845-1945	Sri Lanka Br. Corp.	C	17850, 15120, 15115, 11870
1:45-3:00 p.m.	1845-2000	R. Ivory Coast	C	11920
2:00-2:10 p.m.	1900-1910	R. Tahiti	C	15170, 11825 (exc Sun)
2:00-2:15 p.m.	1900-1915	R. Japan	C	15105
2:00-2:30 p.m.	1900-1930	R. Canada International	A	17820, 15325, 11905
2:00-2:30 p.m.	1900-1930	R. Afghanistan	B	17760, 15260
2:00-3:00 p.m.	1900-2000	B.S.K. Saudi Arabia	C	11770 or 11820 (frequent changes)
2:00-3:30 p.m.	1900-2030	HCJB, Ecuador	C	11855
2:00-5:00 p.m.	1900-2200	VDA	B	21480, 17770, 15295
2:30-3:00 p.m.	1930-2000	V. of Iran	A	21590, 21485, 17870, 17785, 17710
3:00-3:15 p.m.	2000-2015	R. Japan	C	9022
3:00-3:30 p.m.	2000-2030	R. Korea	B	15105
3:00-3:30 p.m.	2000-2030	R. Canada International	C	11860
3:00-3:30 p.m.	2000-2030	Israel R.	A	17820, 15325, 11945, 11905
3:00-6:00 p.m.	2000-2300	AFRTS-Washington	C	11655, 9815
3:00-4:15 p.m.	2000-2115	BBC	A	17765, 15430, 15330, 11790
3:10-4:50 p.m.	2010-2150	R. Habana Cuba	A	17840, 15260, 6175
3:30-4:20 p.m.	2030-2120	R. Nederland	A	17855
3:30-4:30 p.m.	2030-2130	V. of Vietnam	B	21640, 17810, 11740, 11730
3:50-4:40 p.m.	2050-2140	R. Habana Cuba	C	15012, 12035, 10040
4:00-4:15 p.m.	2100-2115	R. Japan	C	17750, 9770
4:00-4:50 p.m.	2100-2150	R. RSA	B	15105
4:15-5:00 p.m.	2115-2200	BBC	B	17780, 15155, 11900
4:30-5:00 p.m.	2130-2200	R. Canada International	A	15260, 6175
4:30-5:00 p.m.	2130-2200	KGEI San Francisco	A	17820, 15325, 15150, 11945
4:30-5:00 p.m.	2130-2200	R. Sofia	C	15280
4:30-5:30 p.m.	2130-2230	R. Baghdad	B	11850, 11750
4:30-6:00 p.m.	2130-2300	V. of Turkey	C	9745
4:40-5:40 p.m.	2140-2240	V. of Free China	C	9665, 9515, 7270, 7170
5:00-5:15 p.m.	2200-2215	R. Yugoslavia	C	17890, 15345
5:00-5:15 p.m.	2200-2215	R. Japan	C	9620
5:00-5:30 p.m.	2200-2230	R. Nacional, Venezuela	B	17755
5:00-5:30 p.m.	2200-2230	R. Norway	B	15400 (irregular)
5:00-5:30 p.m.	2200-2230	V. of Chile	C	9645, 9590 (Sun only)
5:00-5:45 p.m.	2200-2245	BBC	B	15140
5:00-7:00 p.m.	2200-2400	VDA	A	15260, 11910, 9590, 6195, 6175, 5975
5:30-6:00 p.m.	2230-2300	Israel R.	A	26095, 21610, 21460, 17895, 17820
5:45-6:00 p.m.	2245-2300	BBC	A	11655, 9815, 9435, 7412.5
5:45-6:00 p.m.	2245-2300	BBC	A	15260, 11910, 9590, 9410, 7325, 6195, 6175, 5975
5:45-6:00 p.m.	2245-2300	UN Radio	A	15240, 11955 (Mon-Fri)
6:00-6:30 p.m.	2300-2330	BBC	A	15260, 11910, 9590, 9580, 9410, 7325, 6195, 6175, 5975
6:00-6:30 p.m.	2300-2330	R. Japan	B	17755
6:00-6:30 p.m.	2300-2330	R. Sweden	C	11705, 9695
6:00-6:30 p.m.	2300-2330	R. Vilnius	B	7400, 7360, 7215
6:00-6:50 p.m.	2300-2350	Rdif. Argentina	C	11710 (Mon-Fri)
6:00-7:00 p.m.	2300-2400	AFRTS-Washington	A	17765, 15430, 15330, 6030
6:00-7:50 p.m.	2300-2450	R. Pyongyang	C	11535, 9977
6:00-8:00 p.m.	2300-0100	R. Moscow	B	17720, 15425, 15140, 12050, 7440, 7205, 7195, 7130, 7115, 7105, 6125, 5940
6:00-8:00 p.m.	2300-0100	CBC Southern Service	A	5960 (Mon-Fri.)
6:30-7:00 p.m.	2330-2400	V. of Chile	B	15175, 15140
6:30-7:00 p.m.	2330-2400	R. Finland	C	11800, 9565
6:30-7:30 p.m.	2330-2430	BBC	A	15260, 11910, 9590, 9580, 7325, 6175, 6120, 5975

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6:45-7:45 p.m.	2345-2445	R. Japan	B	17825, 15270
7:00-7:15 p.m.	0000-0015	R. Japan	B	17755
7:00-7:25 p.m.	0000-0025	R. Tirana	B	9750, 7065
7:00-7:30 p.m.	0000-0030	R. Norway	C	9590, 6015 (Mon only)
7:00-7:55 p.m.	0000-0055	R. Peking	B	17680, 15520, 15060
7:00-8:00 p.m.	0000-0100	R. Sofia	B	9705
7:00-8:00 p.m.	0000-0100	AFRTS-Washington	A	17765, 15330, 11790, 6030
7:00-9:00 p.m.	0000-0200	VOA	A	15205, 11740, 9650, 6130
7:00-9:00 p.m.	0000-0200	Spanish Foreign R.	B	11880, 9630
7:00-9:00 p.m.	0000-0200	R. Luxembourg	C	6090
7:00 p.m.-1:06 a.m.	0000-0606	CBC Northern Service	B	9625, 6195 (not all Eng.)
7:15-7:30 p.m.	0015-0030	V. of Greece	B	11955, 11730, 9760
7:15-8:00 p.m.	0015-0100	BRT, Belgium	C	6080
7:30-7:50 p.m.	0030-0050	SOORE, Uruguay	C	11885, 9515 (time varies)
7:30-8:00 p.m.	0030-0100	R. Sweden	C	11905
7:30-8:00 p.m.	0030-0100	R. Prague	C	9630, 6055
7:30-8:00 p.m.	0030-0100	R. Kiev	B	17870, 15180, 12000, 7150, 6020, 5980
7:30-10:30 p.m.	0030-0330	BBC	A	15260, 11750, 9580, 9410, 7325, 6175, 6120, 5975
7:30-12:00 p.m.	0030-0500	HCJB, Ecuador	B	11915, 9560
7:35-8:35 p.m.	0035-0135	TWR-Bonaire	B	11925
8:00-8:15 p.m.	0100-0115	R. Japan	B	17755
8:00-8:15 p.m.	0100-0115	Vatican R.	B	11845, 9605, 6015
8:00-8:20 p.m.	0100-0120	RAI, Italy	B	11810, 9575
8:00-8:30 p.m.	0100-0130	R. Canada International	A	11940, 9535
8:00-8:30 p.m.	0100-0130	V. of Chile	B	11890, 11765
8:00-8:45 p.m.	0100-0145	R. Berlin International	C	9730
8:00-8:55 p.m.	0100-0155	R. Prague	B	11990, 9630, 9540, 7345, 5930
8:00-8:55 p.m.	0100-0155	R. Peking	B	15060, 11945, 9940
8:00-9:00 p.m.	0100-0200	V. of Free China	C	17890, 15425, 15345
8:00-9:00 p.m.	0100-0200	AFRTS-Washington	A	17765, 15330, 11790, 6155, 6030
8:00-10:00 p.m.	0100-0300	R. Moscow	B	15425, 15100, 12050, 9700, 9635, 7440, 7205, 7195, 7115, 7105, 6125, 5940
8:00-10:30 p.m.	0100-0330	R. Habana Cuba	A	11930
8:00-10:30 p.m.	0100-0330	R. Australia	B	17795, 21740
8:00-12:00 p.m.	0100-0500	WYFR, Family Radio	A	5985
8:30-8:50 p.m.	0130-0150	V. of Germany	A	11865, 9605, 9565, 9545, 6100, 6085, 6075, 6040
8:30-8:55 p.m.	0130-0155	Austrian Radio	C	9770, 6155
8:30-8:55 p.m.	0130-0155	R. Tirana	B	7120, 6200
8:30-9:25 p.m.	0130-0225	R. Bucharest	C	11940, 11840, 11705, 9690, 9670, 6155, 5990
8:30-9:30 p.m.	0130-0230	R. Japan	B	21640, 17825, 17725, 15195
8:45-9:15 p.m.	0145-0215	Swiss R. International	B	11780-SSB, 11715, 9725, 9660, 6135
9:00-9:15 p.m.	0200-0215	R. Japan	B	17755
9:00-9:30 p.m.	0200-0230	R. Canada International	A	11845, 9535
9:00-9:30 p.m.	0200-0230	R. Norway	B	9645, 9590, 6005 (Mon only)
9:00-9:30 p.m.	0200-0230	R. Budapest	B	15225, 11910, 9833, 9585, 6000, 6080 (not Mon)
9:00-9:30 p.m.	0200-0230	R. Warsaw	C	15120, 11815, 9525, 7270, 7145, 6135, 6095
9:00-9:50 p.m.	0200-0250	R. RSA	B	11900, 9610, 9585, 5980
9:00-9:55 p.m.	0200-0255	R. Peking	B	15060, 12055, 9940
9:00-10:30 p.m.	0200-0330	R. Cairo	B	9475, 6230
9:00-10:30 p.m.	0200-0330	AFRTS-Washington	A	15330, 11805, 11790, 6155, 6030
9:15-9:30 p.m.	0215-0230	V. of Greece	B	11730, 9760, 9610
9:30-9:45 p.m.	0230-0245	R. Pakistan	C	21590, 17830
9:30-9:55 p.m.	0230-0255	R. Tirana	B	7120, 6200
9:30-10:00 p.m.	0230-0300	R. Lebanon	C	11925 (frequent changes)
9:30-10:00 p.m.	0230-0300	R. Sweden	C	11705, 9695
9:30-10:00 p.m.	0230-0300	V. of Chile	B	11890, 11765
9:30-10:15 p.m.	0230-0315	R. Berlin International	C	9730
9:30-10:25 p.m.	0230-0325	R. Nederland	A	9590, 6165
10:00-10:15 p.m.	0300-0315	R. Japan	B	17755
10:00-10:15 p.m.	0300-0315	Austrian Radio	C	9770, 6155 (Sun only)
10:00-10:30 p.m.	0300-0330	R. Canada International	A	11845, 9755, 9535, 5960
10:00-10:30 p.m.	0300-0330	R. Portugal	B	11935, 6025 (Mon -0320)
10:00-10:30 p.m.	0300-0330	R. Budapest	B	15225, 11910, 9833, 9585, 6080, 6000
10:00-10:30 p.m.	0300-0330	R. Warsaw	C	15120, 11815, 9525, 7270, 7145, 6135, 6095
10:00-10:30 p.m.	0300-0330	R. Kiev	B	11860, 9780, 9580, 7400, 7245, 6020, 5980
10:00-10:55 p.m.	0300-0355	R. Prague	B	11990, 9630, 9540, 7345, 5930
10:00-10:55 p.m.	0300-0355	R. Peking	B	15060, 12055, 11650, 9460
10:00-11:00 p.m.	0300-0400	RAE, Argentina	C	9690 (Tue-Sat)
10:00-11:00 p.m.	0300-0400	R. Baghdad	C	11935



10:00-11:00 p.m.	0300-0400	UBC, Uganda	B	15325
10:00-11:00 p.m.	0300-0400	R. Moscow	B	7440, 7205, 7195, 7115, 7105, 6125, 5940
10:00-11:26 p.m.	0300-0426	R. RSA	B	11900, 9585, 7270, 5980, 4990
10:25-10:30 p.m.	0325-0330	V. of Armenia	B	15180, 12000, 9735 (Sun., Wed, Thu, Sat)
10:30-10:55 p.m.	0330-0355	R. Tirana	B	7300, 6200
10:30-10:55 p.m.	0330-0355	Austrian Radio	C	9770, 6155
10:30-11:00 p.m.	0330-0400	R. Australia	B	17795
10:30-11:15 p.m.	0330-0415	R. Berlin International	B	11970, 11890, 11840
10:30-11:45 p.m.	0330-0445	BBC	A	9410, 6175, 6120 (to 0430), 5975
10:30-11:50 p.m.	0330-0450	R. Habana Cuba	A	11930, 11725
10:30-12:00 p.m.	0330-0500	AFRTS-Washington	A	11805, 11790, 9700, 6155, 6030
10:30 p.m.-1:00 a.m.	0330-0600	R. Habana Cuba	A	11760
10:30 p.m.-2:30 a.m.	0330-0730	R. Moscow	B	9735, 9665, 9635, 9610, 9580, 7260, 6150, 5905
11:00-11:15 p.m.	0400-0415	R. Japan	B	15105
11:00-11:15 p.m.	0400-0415	R. Budapest	B	15225, 11910, 9833, 9585, 6000
11:00-11:30 p.m.	0400-0430	R. Bucharest	C	6080 (Wed & Sat)
11:00-11:30 p.m.	0400-0430	V. of Chile	B	11940, 11840, 11705, 9690, 9570, 6155, 5990
11:00-11:30 p.m.	0400-0430	R. Canada International	B	11765
11:00-11:30 p.m.	0400-0430	R. Norway	A	9535, 5960
11:00-11:55 p.m.	0400-0455	R. Peking	B	9550, 6015 (Mon only)
11:00-12:00 p.m.	0400-0500	R. Australia	B	15060, 12055, 11650, 9460
11:30-11:55 p.m.	0430-0455	Austrian R.	B	17795, 15320
11:30-12:00 p.m.	0430-0500	Swiss R. International	C	6015
11:30-12:00 p.m.	0430-0500	R. Sofia	B	9725, 6045
11:45 p.m., 12:45 a.m.	0445-0545	BBC	B	9530
12:00-12:15 a.m.	0500-0515	Israel R.	A	9510, 6175, 5975 (11860 from 0500)
12:00-12:15 a.m.	0500-0515	R. Japan	B	11655, 9833
12:00-12:30 a.m.	0500-0530	R. Portugal	B	15105
12:00-1:00 a.m.	0500-0600	AFRTS, Washington	B	11935, 6025 (Mon -0520)
12:00-1:00 a.m.	0500-0600	R. Australia	A	11805, 9700, 9685, 6155, 6030
12:00-2:00 a.m.	0500-0700	HCB, Ecuador	C	21680, 17890, 17870, 17725, 15240
12:15-1:15 a.m.	0515-0615	Spanish Foreign R.	B	6095, 9560, 11915
12:30-12:50 a.m.	0530-0550	V. of Germany	B	11880, 9630
12:30-1:00 a.m.	0530-0600	V. of Chile	A	11905, 11785, 9545, 6185, 6100, 5960
12:30-1:25 a.m.	0530-0625	R. Nederland	B	11765
12:45-1:00 a.m.	0545-0600	UN Radio	A	9715, 6165
12:45-2:30 a.m.	0545-0730	BBC	A	9620, 6055 (Tue-Sat)
12:55-3:35 a.m.	0555-0835	V. of Nigeria	B	11955, 11860, 9640, 9510, 7150
1:00-1:15 a.m.	0600-0615	R. Japan	B	15120, 11770, 7255
1:00-1:30 a.m.	0600-0630	R. Norway	B	15105
1:00-2:00 a.m.	0600-0700	RAE, Argentina	B	9645 (Mon only)
1:00-2:00 a.m.	0600-0700	AFRTS-Washington	C	11755, 9690, 6120 (Tue-Sat only)
1:00-2:00 a.m.	0600-0700	R. RSA	A	11805, 9700, 9685, 6155, 6095, 6030
1:00-4:15 a.m.	0600-0915	R. Australia	C	17780, 15220
1:15-1:30 a.m.	0615-0630	R. Canada International	B	15320
1:25-3:55 a.m.	0625-0855	V. of Malaysia	B	11825, 11735, 9730, 9655, 6140 (Mon-Fri)
1:30-2:00 a.m.	0630-0700	R. Korea	C	15295, 12350, 9750
1:30-3:00 a.m.	0630-0800	R. Habana Cuba	C	9640
1:45-2:00 a.m.	0645-0700	R. Canada International	A	9525
2:00-2:15 a.m.	0700-0715	R. Japan	B	11825, 11735, 9730, 9655, 6140 (Mon-Fri)
2:00-4:00 a.m.	0700-0900	R. Australia	B	15105
2:00-7:00 a.m.	0700-1200	AFRTS-Washington	B	11740, 9570
2:07-2:15 a.m.	0707-0715	UN Radio	A	9700, 9685, 6155, 6095, 6030
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2:30-3:25 a.m.	0730-0825	R. Nederland	A	6135, 6055 (Tue-Sat)
2:30-4:00 a.m.	0730-0900	BBC	B	9770, 9715
3:00-3:15 a.m.	0800-0815	R. Japan	B	11955, 9640, 9510, 7150
3:30-4:25 a.m.	0830-0925	R. Nederland	B	9505
			B	9715

#### Explanatory Notes.

1. Times in first column are EST. For AST, add 1 hour. CST, subtract 1 hour. MST, subtract 2 hours. PST, subtract 3 hours. Days of week are in GMT.

2. Quality. A—strong signal and very reliable reception. B—regular reception. C—occasional reception under favorable conditions. D—rarely audible. These ratings are for locations in the central USA. European and African stations are in general, more reliably received in eastern North America. Asian and Pacific stations are more reliably received in western North America. North American stations are received well except in areas too close to the transmitter site.

3. The information in this listing is correct to press time. However, frequencies and schedules are constantly changing. Listen to "DX Digest" at 1800, 1900 to Europe, 2000, 0100, 0200, 0300, 0400 on Sunday and 1900 Wednesday to Africa on R. Canada International for late changes.

4. R.—Radio; V.—Voice



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# Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

**Concertone** 727 tape recorder. Schematic or voltage chart. Clarence Lundy, Space 6, 1251 E. Lugonia Ave., Redlands, CA 92373.

**Telequipment** type D43 oscilloscope. Serial #72182. Alwa TP-1001 tape recorder. Any available information. C. Bloch, Springhill Farm, Hillsdale, NY 12529.

**Mercury** model 201 tube type tester. Tube chart and schematic. Ken Layton, 1941½ E. State, Apt. 8C, Olympia, WA 98506.

**Atwater Kent** model E radio. Schematic and owner's manual. Mike Bodner, 4073 Millstream Dr., Murrysville, PA 15668.

**Planola** SR-850 AM-FM stereo auto radio. Schematic and any information. E.E. Leibert, Rt. 4, Box 70, Walla Walla, WA 99362.

**Crownscriber** model CDM-10 cassette tape recorder dictating machine. Schematic and parts source. Gar Miller, 114 Bradwell Rd., Barrington, IL 60010.

**Knight** transistor stereo amplifier model KG-870. Schematic. George Martin, 45-57 167 St., Flushing, NY 11358.

**National Electronics** HRO 500 receiver. Need maintenance manual and schematics. A. Giroux, 555-66-8776, HHT, 2d ACR APO, NY 09093.

**Tektronix** oscilloscope model 545 with type CA plug in. Calibration manual. Bill Heronemus, 138 Franklin Ave., Lewes, DE 19958.

**Supreme Instruments** model 599 tube tester. Schematic and manual. William Groskurth, Box 1244, Terminal A, Toronto, Ontario, Canada, M5W 1G7.

**Hallcrafters** S 40B receiver. Operation manual and schematic. Stanley V. Ryba, 2954 Trimble Paducah, KY 42001.

**Action Labs** CB transceiver type TCV-271-3. Schematic or any available information. Danny Degraff, 20 Birch St., Everett, MA 02149.

**Knight** KG-690 signal tracer. Schematic, operating manual. Richard Roggeveen, 5569 Dunsbury Ct., San Jose, CA 95123.

**Dumont** Labs type 322A oscilloscope. Schematic. Dennis Smith, 19502 Bowers Dr. Topanga, CA 90290.

**Sylvania** type 132 oscilloscope. Operation and service manual. Jerry Eckard, 2412 129th Ave., Southeast, Bellevue, WA 98005.

**Source Industries, Inc.** electrograph 201 dual channel strip chart recorder. Schematic and instruction manual. P. Kalcich, Box 244, El Dorado, AK 71730.

**Precision** E-200 signal generator. Manual and schematic. Bill Hocutt, 926 S. Shades Crest Rd., Bessemer, AL 35020.

**Kenwood** model 1100. Schematic and user's manual. Greg Wright 3318 Emerald Isle Dr., Glendale, CA 91206.

**Sanborn Electronic Switch** model 179-100. Schematic, parts list, service manual. Michael Ames, Dept. D&EA, 214 Van Rensselaer Hall, Ithaca, NY 14853.

**Knight** r-f signal generator. Schematic and construction manual with parts list. David Kisner, 601 E. 12th, Hays, KS 67601.

**Zenith** model 4K035 four-tube radio. Schematic and operator's manual. Daniel Bevina, 506 South 8th St., Galesville, WI 54630.

**Triumph** model 830 oscilloscope. Schematics or any information. R. Rockwell, 2 Forest Rd., Burlington, MA 01803.

**Knight** kit model KG 988A stereo receiver. Schematic and parts list. Ken Bryant, 97 Williamsburg Dr., Monroe, CT 06468.

**Heathkit** oscilloscope model OL-1. Schematic. Robert Dole, Route 1, Alemnna, KS 67622.

**Non-Linear Systems** X-2 digital multimeter. Circuit board needed. Joaquín Araujo, Box 384, San Antonio, TX 78292.

**Allied Knight** model KG-50. Schematic needed. Joseph Szomolyai, 15418 Collins, Romulus, MI 48174.

**Signal Corp.** tube tester I-77-B with adapter TTA-2B. Need updated tube charts. J. Stiles, 1420 Sunset Dr., Fairborn, OH 45324.

**Crosby** model 1318 (T 316). Schematic needed. Jerry Unger, RR 1, Box 537, Buchanan, MI 49107.

**National** high frequency receiver type NC-200. Owners'/operation manual, schematic, parts list and any other information. George Patchan, 3338 Slade Ct., Falls Church, VA 22042.

**Cubic Corp.** model V-45 voltmeter. Operating instructions, repair manual and schematic. Henry Heintz, 15939 Norborne, Redford, MI 48239.

**Allied Radio Knight** amateur transmitter model T-60. Operation and assembly manual. John Ross, Oakledge Rd., Brunswick, ME 04011.

**Tennelec** monitor, memoryscan model MS-1. Schematic and alignment procedure. Thomas R. Cannon, 7 Wistar St., Claymont, DE 19703.

**Heathkit** HW-2021 2-meter transceiver. Schematic diagram and parts list. Mark Canavan, 163 Thoms Cr., New Market, Ontario, Canada, L3Y-1C9.

**Hallcrafters** SX 110 receiver. Schematic and manual. Gary Lutes, Box 94, Beattyville, KY 41311.

**Paco** model S-55 oscilloscope. Need power transformer #P18-183. George Chamberlin, 2139 Penna Ave., East Liverpool, OH 43920.

**Clough-Brengle** model 105 oscilloscope. Manual and schematic. Edna Farkas, 651 Sanford Ave., Akron, OH 44305.

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## ANSWERS ELECTRONICS IQ QUIZ

(On page 65)

- Answer: A. The bulbs correspond as follows: 1-C, 2-B, 3-E, 4-F, 5-A, 6-D.
- Answer: A. The combined resistance of resistances in parallel is always less than the smallest one in the group.
- Answer: C. All of the diodes are reverse-biased except C which is forward-biased.
- Answer: 7 A. The sum of the currents entering a junction must equal the sum of the currents leaving it. With 25 amperes flowing toward the center and 18 A flowing away, current G must be 7 A.
- Answer: D. All of the resistor combinations have an equivalent resistance of 12 ohms except D.
- Answer: C. Drawing C is upside down. Drawing B is reversed and rightside up, but one of the holes has been moved.
- Answer: 5864. A kilowatt-hour meter is read from left to right.
- Answer: 1-B, 2-C, 3-A.
- Answer: C. All of the components have the names of animals except C. A: crocodile clip; B: pigtailed; C: banana plug; D: rabbit ears.
- Answer: 24. A = 6, add 3; B = 9, add 4; C = 13, add 5; D = 18, add 6; E = 24.



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74LS02	15	74LS49	89	74LS125	59	74LS174	89	74LS260	29	74LS374	175
74LS03	15	74LS51	19	74LS126	59	74LS175	89	74LS261	185	74LS375	65
74LS04	19	74LS54	19	74LS132	79	74LS181	250	74LS268	39	74LS377	150
74LS05	19	74LS55	19	74LS133	29	74LS183	350	74LS273	165	74LS378	125
74LS08	19	74LS63	150	74LS136	39	74LS190	89	74LS275	450	74LS379	135
74LS09	19	74LS73	29	74LS138	64	74LS191	89	74LS279	59	74LS386	49
74LS10	15	74LS74	35	74LS139	64	74LS192	95	74LS280	175	74LS390	150
74LS11	19	74LS75	49	74LS145	99	74LS193	95	74LS283	85	74LS393	125
74LS12	19	74LS76	39	74LS147	195	74LS194	75	74LS290	85	74LS395	150
74LS13	35	74LS78	39	74LS148	99	74LS195	66	74LS293	110	74LS396	170
74LS14	59	74LS83	79	74LS151	59	74LS196	109	74LS295	125	74LS398	265
74LS15	19	74LS85	99	74LS153	59	74LS197	109	74LS298	125	74LS399	150
74LS20	15	74LS86	35	74LS155	99	74LS221	125	74LS299	295	74LS424	450
74LS21	19	74LS90	59	74LS156	80	74LS240	195	74LS324	125	74LS445	125
74LS22	19	74LS91	59	74LS157	59	74LS241	195	74LS325	255	74LS447	125
74LS26	25	74LS92	59	74LS158	69	74LS242	195	74LS326	255	74LS490	195
74LS27	21	74LS93	49	74LS160	84	74LS243	195	74LS327	255	74LS668	90
74LS28	21	74LS95	70	74LS161	84	74LS244	195	74LS347	125	74LS669	90
74LS30	15	74LS96	99	74LS162	84	74LS245	195	74LS348	175	74LS670	200
74LS32	25	74LS107	39	74LS163	84	74LS247	125	74LS352	135		
74LS33	27	74LS109	32	74LS164	89	74LS248	125	74LS351	135		
74LS37	23	74LS112	32	74LS165	125	74LS249	125	74LS362	700		
74LS38	23	74LS113	39	74LS166	145	74LS251	85	74LS365	55		
74LS40	19	74LS114	39	74LS168	150	74LS253	85	74LS366	55		
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SN7729N 20		SN74440N 99
SN7730N 20		SN74441N 99
SN7731N 20		SN74442N 99
SN7732N 20		SN74443N 99

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CD4002	23	CD4071	23
CD4003	1.19	CD4072	23
CD4004	1.19	CD4073	1.39
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CD4010	49	CD4077	1.39
CD4011	23	CD4078	1.39
CD4012	25	CD4079	1.39
CD4013	49	CD4080	1.39
CD4014	1.39	CD4081	1.39
CD4015	1.19	CD4082	1.39
CD4016	1.19	CD4083	1.39
CD4017	1.19	CD4084	1.39
CD4018	99	CD4085	1.39
CD4019	49	CD4086	1.39
CD4020	1.19	CD4087	1.39
CD4021	1.39	CD4088	1.39
CD4022	1.19	CD4089	1.39
CD4023	23	CD4090	1.39
CD4024	79	CD4091	1.39
CD4025	23	CD4092	1.39
CD4026	2.25	CD4093	1.39
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74C00			74C163	2.49	
74C00	39		74C164	2.49	
74C01	39		74C165	2.60	
74C02	39	74C85	2.49	74C173	2.60
74C03	49	74C90	1.95	74C192	2.49
74C04	39	74C93	1.95	74C193	2.49
74C05	1.95	74C95	1.95	74C196	4.49
74C06	39	74C107	1.25	74C922	5.95
74C07	39	74C151	2.80	74C933	6.25
74C08	1.95	74C152	3.00	74C935	8.95
74C09	2.49	74C157	2.15	74C936	8.95
74C10	39	74C160	2.49	80C95	1.50
74C11	39	74C161	2.49	80C97	1.50
LINEAR					
78MC	1.75		LM7100	75	
LM100H	39		LM7101	100	
LM103D	39		LM7230H	50	
LM103D	39	LM103R-18	1.35		



# Jameco Kits

## Regulated Power Supply



- Uses LM 309K
- Heat sink provided
- P.C. board construction
- Provides a solid 1 amp @ 5V
- Includes components, hardware and instructions
- Sizes: 3-1/2" x 5" x 2" high

**JE200 \$14.95**

## Function Generator Kit



- Provides 3 basic waveforms: sine, triangle & square wave
- Frequency range from 1 Hz to 100K Hz
- Output amplitude from 0-volts to over 6 volts (peak to peak)
- Uses a 12V supply or a ± 6V split supply
- Includes chip, P.C. board, components and instructions.

**JE2206B \$19.95**

## Digital Stopwatch Kit



- Use Intersil 7205 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
- Times to 59 min. 59.59 sec. with auto reset
- Quartz crystal controlled
- Three stopwatches in one: single event, split (cumulative) and taylor (sequential timing)
- Uses 3 penlite batteries
- Size: 4.5" x 2.15" x .90"

**JE900 \$39.95**

## 4-Digit Clock Kit



- Bright .357" ht. red display
- Sequential flashing colon
- 12 or 24 hour operation
- Extruded aluminum case (black)
- Pressure switches for hours, minutes and hold modes
- Includes all components, case and wall transformer
- Size: 3-1/4" x 1-3/4" x 1-1/4"

**JE730 \$14.95**

## 6-Digit Clock Kit

- Bright .300 ht. common cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 20 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6-3/4" x 3-1/8" x 1-3/4"

**JE701 \$19.95**

## Jumbo 6-Digit Clock Kit

- Four .630" ht. and two .300" ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6-3/4" x 3-1/8" x 1-3/4"

**JE747 \$29.95**

## MICROPROCESSOR COMPONENTS

8080/8085 SUPPORT DEVICES			MICROPROCESSOR MANUALS		
8080A	CPU	\$ 9.95	M-280	User Manual	\$7.50
8212	8-Bit Input/Output	3.25	M-COP1802	User Manual	7.50
8214	Priority Interrupt Control	5.95	M-2550	User Manual	5.00
8216	Bi-Directional Bus Driver	3.49			
8224	Clock Generator/Driver	3.95			
8226	Bus Driver	3.49			
8228	System Controller/Bus Driver	5.95	2513(2140)	Character Generator(upper case)	59.95
8238	System Controller	5.95	2513(3021)	Character Generator(lower case)	9.95
8251	Prog. Comm. I/O (USART)	7.49	2518	Character Generator	10.95
8253	Prog. Interval Timer	14.95	MM5330N	2048-Bit Read Only Memory	1.95
8255	Prog. Periph. I/O (PPI)	9.95			
8257	Prog. DMA Control	19.95			
8259	Prog. Interrupt Control	18.95			
8080/8085 SUPPORT DEVICES			ROM'S		
MC6800	MPU	\$14.95	1101	256K1 Static	\$1.49
MC6802CP	MPU with Clock and Ram	24.95	1103	1024K1 Dynamic	3.99
MC6810AP	128K Static Ram	4.95	2101(8101)	256K1 Static	3.95
MC6821	Priority Interrupt Controller	2.95	2102	1024K1 Static	1.75
MC6828	1024X8 Bit ROM (MC68A30-8)	14.95	21102	1024K1 Static	1.95
MC6830L8	Asynchronous Counter Adapter	7.95	2111(8111)	256K4 Static	3.95
MC6852	Synchronous Serial Data Adapter	9.95	2112	256K4 Static	4.95
MC6860	0-500 bps Digital MODEM	12.95	2114	1024X4 Static 450ns	4.95
MC6862	2400 bps Modulator	14.95	2114L	1024X4 Static 450ns low power	10.95
MC6880A	Quad 3-State Bus. Trans. (MC68T26)	2.95	2144-3	1024X4 Static 300ns low power	11.95
MICROPROCESSOR CHIPS—MISCELLANEOUS			3280(2107)	4096K1 Dynamic	4.95
Z80(780C)	CPU	\$19.95	7489	16K4 Static	1.75
Z80A(780-1)	CPU	24.95	7489	16K4 Static	1.75
CDP1802	CPU	19.95	7489	16K4 Static	1.75
2050	MPU	19.95	7489	16K4 Static	1.75
8035	8-Bit MPU w/clock, RAM, I/O lines	19.95	7489	16K4 Static	1.75
PD805	CPU	19.95	7489	16K4 Static	1.75
TMS9900QL	16-Bit MPU w/hardware, multiply & divide	49.95	7489	16K4 Static	1.75
SHIFT REGISTERS			7489	16K4 Static	1.75
MM500H	Dual 25 Bit Dynamic	\$ 5.50	7489	16K4 Static	1.75
MM502H	Dual 50 Bit Dynamic	5.50	7489	16K4 Static	1.75
MM504H	Dual 16 Bit Static	5.50	7489	16K4 Static	1.75
MM505H	Dual 100 Bit Static	5.50	7489	16K4 Static	1.75
MM507H	Dual 64 Bit Accumulator	5.50	7489	16K4 Static	1.75
MM5015H	500-512 Bit Dynamic	3.95	7489	16K4 Static	1.75
2504T	1024 Dynamic	8.95	7489	16K4 Static	1.75
2518	Hex 32 Bit Static	4.95	7489	16K4 Static	1.75
2522	Dual 132 Bit Static	2.95	7489	16K4 Static	1.75
2534	512 Static	9.95	7489	16K4 Static	1.75
2525	1024 Dynamic	2.95	7489	16K4 Static	1.75
2527	Dual 256 Bit Static	2.95	7489	16K4 Static	1.75
2528	Dual 256 Static	4.00	7489	16K4 Static	1.75
2529	Dual 240 Bit Static	2.95	7489	16K4 Static	1.75
2532	Quad 80 Bit Static	2.95	7489	16K4 Static	1.75
2533	1024 Static	2.95	7489	16K4 Static	1.75
3341	Fifo	6.95	7489	16K4 Static	1.75
74LS670	4K4 Register File (TriState)	1.95	7489	16K4 Static	1.75
UART'S			7489	16K4 Static	1.75
A-Y-5-1013	30K BAUD	5.95	7489	16K4 Static	1.75



A digital multimeter used to mean an expensive, bulky piece of equipment. The Sinclair PDM-35 changes that. It's as small as the functions and features you want in a digital multimeter, yet it's actually packaged in a rugged but light plastic case, ready to go anywhere.

**XMAS SPECIAL - Get your PDM-35 PLUS the 117 volt AC Adapter and Padded carrying case for only (Retail value \$73.85) \$64.50**



**Model 2800 \$99.95**  
Comes with test leads, operating manual and spare fuse

**Accessories:**  
AC Adapter BC-28 \$9.00  
Rechargeable Batteries BP-26 20.00  
Carrying Case LC-28 7.50

**The Sinclair PDM-35. A personal digital multimeter for only \$59.95**

Technical specification  
DC Voltage (4 ranges)  
Range 1 mA to 2000 V  
Accuracy of reading 1.0% ± 1 count  
Scale 10 Max input impedance  
AC Voltage (40 Hz-4 kHz)  
Range 1 V to 500 V  
Accuracy of reading 1.0% ± 2 counts  
DC Current (8 ranges)  
Range 1 nA to 200 mA  
Accuracy of reading 1.0% ± 1 count  
Note: Max resolution 0.1 nA  
Resistance (8 ranges)  
Range 1 Ω to 20 MΩ  
Accuracy of reading 1.5% ± 1 count  
Also provides 5 function-test ranges  
Dimensions: 6 in x 3 in x 1 in  
Weight: 6 oz  
Power supply: 1 V batteries or Sinclair AC adapter (battery not included)  
Socket: standard 4 mm for resident plug  
Note: AC adapter not included  
No 10 pin power lead included  
Warning: water



**Accessories for Mini-Max**  
Part No. Description Price  
MM-A4 Antenna \$ 3.95  
MM-C5 Carrying case 5.95  
MM-IP6 Input cable with clip leads 3.95  
MM-AC2 110V adapter 9.95  
MM-AC3 220V adapter 9.95

**MINI-MAX \$89.95**  
Spec Sheets - 25¢  
1979 Catalog Available—Send 41¢ stamp

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## The Incredible "Pennywhistle 103"

**\$139.95 Kit Only**

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modern and terminal for telephone, hamming and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method . . . . . Frequency-Shift Keying, full-duplex (half-duplex selectable)  
Maximum Data Rate . . . . . 300 Baud  
Data Format . . . . . Asynchronous Serial (return to mark level required between each character)  
Receive Channel Frequencies . . . . . 2225 Hz for space, 2225 Hz for mark, 1070 space, 1270 mark, High 025 space, 2225 mark  
Transmit Channel Frequencies . . . . . Switch selectable, Low (normal) 1070 space, 1270 mark, High 025 space, 2225 mark  
Receive Sensitivity . . . . . 45 dbm acoustically coupled  
Transmit Level . . . . . 15 dbm nominal Adjustable from 6 dbm to 20 dbm  
Receive Frequency Tolerance . . . . . Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz (displaced and non-polar)  
Digital Data Interface . . . . . EIA RS-232C or 20 mA current loop (receiver is open-collector and non-polar)  
Power Requirements . . . . . 120 VAC, single phase, 10 Watts  
Physical . . . . . All components mount on a single 5" by 9" printed circuit board. All components included  
Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

**TRS-80 16K Conversion Kit**  
Expand your 4K TRS-80 System to 16K. Kit comes complete with:  
\* 8 each UPD416 (16K Dynamic Rams)  
\* Documentation for conversion

**TRS-16K \$115.00**  
Special Offer - Order both your TRS-16K and the Sup'R' MOD II Interface kit together (retail value \$144.95) for only \$139.95

## COMPUTER CASSETTES

\* 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES  
\* PLASTIC CASE INCLUDED  
\* 12 CASSETTE CAPACITY  
\* ADDITIONAL CASSETTES AVAILABLE #C-15-S2-50 ea  
**CAS-6 \$14.95**  
(Case and 6 Cassettes)

## SUP'R' MOD II

**UHF Channel 33 TV Interface Unit Kit**  
\* Wide Band B/W or Color System  
\* Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, IRS-80, Challenger, etc.  
\* MOD II is pretuned to Channel 33 (UHF).  
\* Includes coaxial cable and antenna transformer.

**MOD II \$29.95 Kit**

## Custom Cables & Jumpers

DB 25 Series Cables			
Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 ft.	2-DB25P	\$15.95 ea.
DB25P-4-S	4 ft.	1-DB25P/1-25S	\$16.95 ea.
DB25S-4-S	4 ft.	2-DB25S	\$17.95 ea.
Dip Jumpers			
DJ14-1	1 ft.	1 Pin	\$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-16	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

## CONNECTORS

**25 Pin-D Subminiature**  
DB25P(as pictured) PLUG \$2.95  
DB25S SOCKET 3.50  
DB51226-1 Cable Cover for DB25 P or S 1.75

## 63-Key Unencoded Keyboard

This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **\$29.95/each**

**Hexadecimal Unencoded Keypad**  
19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **\$10.95/each**

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By National Semiconductor and Motorola — first quality

Type	Cat. No.	ONLY
301CN	276-017	49c
324N	276-1711	1.49
339N	276-1712	1.49
386CN	276-1731	99c
555CN	276-1723	79c
556CN	276-1728	1.39
566CN	276-1724	1.69
567CN	276-1721	1.99
723CN	276-1740	69c
741CN	276-007	49c
741H	276-010	49c
3900N	276-1713	99c
3909N	276-1705	99c
4558CN	276-038	79c
75491	276-1701	99c
75492	276-1702	99c
7805	276-1770	1.29
7812	276-1771	1.29
7815	276-1772	1.29

### Hand-Held 6-Digit Frequency Counter

- Counts from 100 Hz to 45 MHz
- kHz and MHz Decimals

# 99<sup>95</sup>

A high quality "pocket" counter with accuracy of 3ppm at 25°C or less than 30 Hz at 10 MHz! Overload-protected 1-meg input. Sensitivity, 30 mV up to 30 MHz. Lead-zero blanking. Just 3x4½". With mini-rod antenna, leads, case, instructions. Requires 9V alkaline battery. 22-351 ..... 99.95

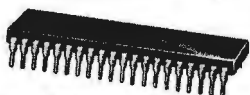


### Wire Wrapping Accessories



IC Socket Wrapping Tool. Strips and wraps 30-gauge wire. 276-1570 ..... 6.95  
14-Pin Wire Wrapping Sockets. 276-1993 ..... 2/1.29  
16-Pin Wire Wrapping Sockets. 276-1994 ..... 2/1.39  
DIP Header. 16 pins. 276-1960 ..... 1.23  
50' Red 30-ga. Kynar® Wire. 276-501 ..... 1.99  
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8-Bit Data Bus,  
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8080A Microprocessor. 100% prime CPU handles up to 65K bytes memory. 276-2510 ..... 12.95

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Under 450 nS  
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2102 1K Static RAM. Low power version. 16-pin DIP. Buy 8 and save! 276-2501 ..... 2.49 Ea. or 8/14.95

### TTL and CMOS Logic ICs

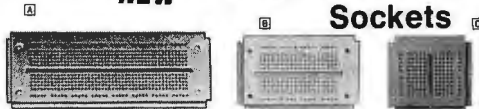
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Direct from  
Motorola and  
National Semiconductor



Type	Cat. No.	ONLY
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7402	276-1811	39c
7404	276-1802	35c
7406	276-1821	49c
7410	276-1807	39c
7413	276-1815	79c
7420	276-1809	39c
7427	276-1823	49c
7432	276-1824	49c
7441	276-1804	99c
7447	276-1805	99c
7448	276-1816	99c
7451	276-1825	39c
7473	276-1803	49c
7474	276-1818	49c
7475	276-1806	79c
7476	276-1813	59c
7485	276-1826	1.19
7486	276-1827	49c
7490	276-1808	79c
7492	276-1819	89c
74123	276-1817	89c
74145	276-1828	1.19
74150	276-1829	1.39
74154	276-1834	1.29
74192	276-1831	1.19
74193	276-1820	1.19
74194	276-1832	1.19
74196	276-1833	1.29
4001	276-2401	49c
4011	276-2411	49c
4013	276-2413	89c
4017	276-2417	1.49
4020	276-2420	1.49
4027	276-2427	89c
4049	276-2449	89c
4050	276-2450	69c
4511	276-2447	1.69
4518	276-2490	1.49

NEW

### IC Breadboard Sockets



Modular boards snap together and feature standard 0.3" center. Accepts 22 through 30-gauge solid hookup wire.

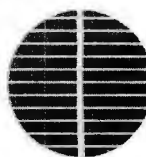
- 550 connections in 2 bus strips of 40 tie points each with 47 rows of 5 connected tie points. 2½x6". 276-174 ..... 9.95
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SALE

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Highly efficient! Delivers up to 400 mA at 0.5V. Ideal for solar power projects, battery charging and operating electronic equipment. 276-121 ..... 5.99

### Low-Cost Power Transformers

- Primaries Designed to Operate from 120VAC, 60 Hz
- Solder Lugs for Easy Wiring or PC Board Mounting



Volts	Current	Cat. No.	Each	Volts	Current	Cat. No.	Each
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24	300 mA	273-1386	2.49	12	5A	273-1513	8.95
24	1.2A	273-1480	2.99	18 CT*	4A	273-1514	8.95
12.6 CT	1.2A	273-1505	2.89	18 CT*	2A	273-1515	4.99

\* Ideal for 5V (using CT) or 12V solid-state regulators

### NEW 3-Amp 4PDT Relay



With Clear  
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Cover

Switch up to four different circuits! Contacts rated 3 amps at 125VAC, 12VDC coil, 160 ohms resistance. Solder terminals. Just 1½x1½x1½". 275-214 ..... 4.99

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Rated 6 Amps  
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Mounts in ¾" round hole—no need to cut square opening. SPST Black. 275-641 ..... 1.69  
SPDT Red. 275-642 ..... 1.89  
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### Lighted DPDT Pushbutton Switch

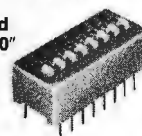
NEW



Push-on/push-off switch rated 4A at 12VDC. Button glows red in "on" position. Mounts in 9/16" hole. U.L. listed. 275-675 ..... 4.69

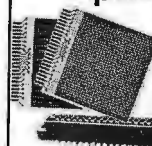
### 8-Rocker DIP Switch

Standard  
.100x.300"  
DIP



Designed for easy change of preset logic states in digital circuits. Fits 16-pin IC socket or mounts on PC board. 275-1301 ..... 1.99

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Digital. 276-156 ..... 4.49  
Op-Amp. 276-157 ..... 4.49  
22-Pin Dual Connector. 276-1551 ..... 2.99

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46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
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31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120

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How many? ☐ 1-2 ☐ 3-4 ☐ 5-8 ☐ 9-12 ☐ over 12

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120



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**Stereo**  
**Review**  
**SRT14**



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**And you can do it all without any instruments . . . by ear alone.**

Included with the SRT14 is a detailed instruction manual complete with charts, tables, and diagrams. This takes you step by step through the testing process, explains the significance of each test, tells you what to listen for, describes any aberrations in system response, and it details corrective procedures.

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- STEREO SEPARATION
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- PHONO-CARTRIDGE TRACKING, LOW FREQUENCY
- CHANNEL BALANCE
- PHASE TEST, SPEAKERS AND PHONO-CARTRIDGE
- NOISE TEST
- RECORD-PLAYER FLUTTER TEST
- FREQUENCY-RESPONSE SWEEP, 10,000 TO 40,000 HZ
- FREQUENCY-RESPONSE SWEEP, 500 TO 20,000 HZ
- SQUARE-WAVE TEST
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- INTERMODULATION-DISTORTION TEST
- ANTISKATING TEST
- 1,000-HZ REFERENCE TONES
- FLUTTER AND SPEED TEST
- STEREO-SPREAD TEST

START GETTING THE MOST OUT OF YOUR STEREO SYSTEM. MAKE THE SRT14 YOUR NEXT RECORD PURCHASE.

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**ORDER FROM:** TEST RECORD, Dept. 30013, P.O. Box 278, Pratt Station, B'klyn, N.Y. 11205.



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WE'RE PUTTING "GREENBACKS" IN YOUR POCKET!

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Easy to assemble! Uses LM340K positive voltage regulators. Reverse leads for a negative supply! Buy 2 for a plus/minus supply! Complete kit, nothing else to buy! (case not included) With step by step instructions. Wt. 4 lbs. Size 6 1/2" x 4 x 2 1/4"



Cat. No.	Volts
3357	12
3358	15
3359	18

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Order by Cat. No. 5278 and PIV

PIV	10 for	25 for
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50	10 for	1.09
100	10 for	1.29
200	10 for	1.49
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## MOTOR SPEED CONTROL "BASIC" KIT

\$2.95

Controls up to 10 Amps, 1000 watts! Works with noninductive type motors and incandescent lights. Varies from 5% to 95%. Wt. 10 oz. Cat. No. 5327

\*Basic kit include all necessary electronic components, less PCB board, case, line cord, transformer, or battery. Easy to breadboard, with instructions.

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Cat. No.	Type	PIV	Sale
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Order by Cat. No.

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\*Famous USA Makers! • 4-11/16" sq. 1 1/2" deep.

## 30 WATT STEREO AMPLIFIER KIT

\$24.95

Easy to build, assemblies in minutes. Uses two 15 watt Hybrid Amplifier Modules with heat sinks included! Power output 2 x 15W RMS, both channels into 8 ohms from 40-22,000 Hz. Total distortion less than 1%. Size: 5 1/4 x 2 3/4". Wt. 1 lb. Cat. No. 5408 Made For Fisher!

## TRANSISTORS

TYPE	SALE	TYPE	SALE
5N7400	.12	5N7492	.39
5N7401	.12	5N7493	.39
5N7402	.14	5N7494	.49
5N7403	.12	5N7495	.39
5N7404	.14	5N7496	.12
5N7405	.14	5N7497	.12
5N7406	.12	5N7498	.12
5N7407	.20	5N7499	.79
5N7408	.12	5N7500	.79
5N7409	.12	5N7501	.79
5N7410	.12	5N7502	.79
5N7411	.12	5N7503	.79
5N7412	.12	5N7504	.79
5N7413	.12	5N7505	.79
5N7414	.12	5N7506	.79
5N7415	.12	5N7507	.79
5N7416	.12	5N7508	.79
5N7417	.12	5N7509	.79
5N7418	.12	5N7510	.79
5N7419	.12	5N7511	.79
5N7420	.12	5N7512	.79
5N7421	.12	5N7513	.79
5N7422	.12	5N7514	.79
5N7423	.12	5N7515	.79
5N7424	.12	5N7516	.79
5N7425	.12	5N7517	.79
5N7426	.12	5N7518	.79
5N7427	.12	5N7519	.79
5N7428	.12	5N7520	.79
5N7429	.12	5N7521	.79
5N7430	.12	5N7522	.79
5N7431	.12	5N7523	.79
5N7432	.12	5N7524	.79
5N7433	.12	5N7525	.79
5N7434	.12	5N7526	.79
5N7435	.12	5N7527	.79
5N7436	.12	5N7528	.79
5N7437	.12	5N7529	.79
5N7438	.12	5N7530	.79
5N7439	.12	5N7531	.79
5N7440	.12	5N7532	.79
5N7441	.12	5N7533	.79
5N7442	.12	5N7534	.79
5N7443	.12	5N7535	.79
5N7444	.12	5N7536	.79
5N7445	.12	5N7537	.79
5N7446	.12	5N7538	.79
5N7447	.12	5N7539	.79
5N7448	.12	5N7540	.79
5N7449	.12	5N7541	.79
5N7450	.12	5N7542	.79
5N7451	.12	5N7543	.79
5N7452	.12	5N7544	.79
5N7453	.12	5N7545	.79
5N7454	.12	5N7546	.79
5N7455	.12	5N7547	.79
5N7456	.12	5N7548	.79
5N7457	.12	5N7549	.79
5N7458	.12	5N7550	.79
5N7459	.12	5N7551	.79
5N7460	.12	5N7552	.79
5N7461	.12	5N7553	.79
5N7462	.12	5N7554	.79
5N7463	.12	5N7555	.79
5N7464	.12	5N7556	.79
5N7465	.12	5N7557	.79
5N7466	.12	5N7558	.79
5N7467	.12	5N7559	.79
5N7468	.12	5N7560	.79
5N7469	.12	5N7561	.79
5N7470	.12	5N7562	.79
5N7471	.12	5N7563	.79
5N7472	.12	5N7564	.79
5N7473	.12	5N7565	.79
5N7474	.12	5N7566	.79
5N7475	.12	5N7567	.79
5N7476	.12	5N7568	.79
5N7477	.12	5N7569	.79
5N7478	.12	5N7570	.79
5N7479	.12	5N7571	.79
5N7480	.12	5N7572	.79
5N7481	.12	5N7573	.79
5N7482	.12	5N7574	.79
5N7483	.12	5N7575	.79
5N7484	.12	5N7576	.79
5N7485	.12	5N7577	.79
5N7486	.12	5N7578	.79
5N7487	.12	5N7579	.79
5N7488	.12	5N7580	.79
5N7489	.12	5N7581	.79
5N7490	.12	5N7582	.79
5N7491	.12	5N7583	.79

## FULL WAVE BRIDGE RECTIFIERS

PIV	2 AMP (#1348)	6 AMP (#2458)	10 AMP (#2447)	25 AMP (#2273)
50	.58	.99	1.49	1.79
100	.79	1.25	1.89	2.25
200	.99	1.49	2.09	2.49
400	1.19	1.69	2.29	2.69
600	1.39	1.89	2.49	2.89
800	1.59	2.09	2.69	3.09

Order by Catalog Number and voltage.

NEW!

## DIGITAL CAPACITANCE METER KIT



• 5 Ranges: Measure any capacitor value from 100 pF to 10,000 uF! Five ranges: 0.1uF, 10uF, 100uF, 1000uF, 10,000uF. Also tests leakage! Directly reads all types of capacitors at the touch of a button. Easy to assemble! Complete kit, nothing else required. With step-by-step instructions. Size 6 1/4 x 2 1/4" deep, vinyl covered wooden cabinet. Wt. 2 lbs.

Cat. No. 5238 Capacitance Meter Kit \$69.95  
Cat. No. 5239 Capacitance Meter Wired \$95

• Four .5" digits!  
• You've seen it at twice the price!

## BARGAIN PRICED ONE-LINE SPECIALS

ULTRASONIC TRANSDUCER, 42kHz, alarm, remote cont. (#5378)	1.49
DYNAMIC MIKE, 500 ohm impedance, with stand. (#5330)	1.95
LED RAD DIODES, emits coherent beam, 5-W. (#3508)	6.98
12V CATCH RELAY, 5A contacts, 500V, 700 ohms (#4032)	1.00
RED DISC SWITCHES, 5A, mostly marked; pop values (#3841)	1.00
LONG LEAD DISC CAPACITORS, pop values, ass'd. (#2581)	100 for \$2.00
TRANSISTOR LYTICS, ass't. pop values, upright, axial. (#2747)	50 for \$2.00
MOLEX IC SOCKET PINS, cut to any length. (#3144)	200 for \$2.00
AXIAL ELECTRODS, ass'd. values & capacitance. (#3277)	40 for \$2.00
LED DRIVER IC's, untested, like 7541-2, 505+ good. (#3380)	6 for \$1.00
JUMBO RED LEADS, 100% prime, long leads. (#3381)	15 for \$2.00
LINE CORDS, 10ga, 2 cond, with plug, 5 ft. (#3843)	10 for \$2.00
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UTILITY AC OUTLET, rect mounting. (#3582)	6 for \$1.00
1 AMP CIRCUIT BREAKERS, glass, thermal. (#3901)	2 for \$1.00
CAPACITOR SPECIALS, discs, mylar, teflon, etc. (#2738)	100 for \$2.00
VOLTAGE REGULATORS, hobby LM320, 340, 70-2 (#3330)	10 for \$2.00
PANEL SWITCHES, slides, rotaries, mod, etc. (#3268)	30 for \$2.00
RESISTOR SPECIAL, 1/4 to 1W, carbon, metal. (#3054)	200 for \$2.00
HALF WATERS, resistors, carbon, metal. (#3048)	100 for \$2.00
IC SOCKET IC BOMBAZE, 14 pin, 28 pin, 40 pin, 80 pin, 140 pin, 160 pin, 200 pin, 240 pin, 280 pin, 320 pin, 360 pin, 400 pin, 440 pin, 480 pin, 520 pin, 560 pin, 600 pin, 640 pin, 680 pin, 720 pin, 760 pin, 800 pin, 840 pin, 880 pin, 920 pin, 960 pin, 1000 pin, 1040 pin, 1080 pin, 1120 pin, 1160 pin, 1200 pin, 1240 pin, 1280 pin, 1320 pin, 1360 pin, 1400 pin, 1440 pin, 1480 pin, 1520 pin, 1560 pin, 1600 pin, 1640 pin, 1680 pin, 1720 pin, 1760 pin, 1800 pin, 1840 pin, 1880 pin, 1920 pin, 1960 pin, 2000 pin, 2040 pin, 2080 pin, 2120 pin, 2160 pin, 2200 pin, 2240 pin, 2280 pin, 2320 pin, 2360 pin, 2400 pin, 2440 pin, 2480 pin, 2520 pin, 2560 pin, 2600 pin, 2640 pin, 2680 pin, 2720 pin, 2760 pin, 2800 pin, 2840 pin, 2880 pin, 2920 pin, 2960 pin, 3000 pin, 3040 pin, 3080 pin, 3120 pin, 3160 pin, 3200 pin, 3240 pin, 3280 pin, 3320 pin, 3360 pin, 3400 pin, 3440 pin, 3480 pin, 3520 pin, 3560 pin, 3600 pin, 3640 pin, 3680 pin, 3720 pin, 3760 pin, 3800 pin, 3840 pin, 3880 pin, 3920 pin, 3960 pin, 4000 pin, 4040 pin, 4080 pin, 4120 pin, 4160 pin, 4200 pin, 4240 pin, 4280 pin, 4320 pin, 4360 pin, 4400 pin, 4440 pin, 4480 pin, 4520 pin, 4560 pin, 4600 pin, 4640 pin, 4680 pin, 4720 pin, 4760 pin, 4800 pin, 4840 pin, 4880 pin, 4920 pin, 4960 pin, 5000 pin, 5040 pin, 5080 pin, 5120 pin, 5160 pin, 5200 pin, 5240 pin, 5280 pin, 5320 pin, 5360 pin, 5400 pin, 5440 pin, 5480 pin, 5520 pin, 5560 pin, 5600 pin, 5640 pin, 5680 pin, 5720 pin, 5760 pin, 5800 pin, 5840 pin, 5880 pin, 5920 pin, 5960 pin, 6000 pin, 6040 pin, 6080 pin, 6120 pin, 6160 pin, 6200 pin, 6240 pin, 6280 pin, 6320 pin, 6360 pin, 6400 pin, 6440 pin, 6480 pin, 6520 pin, 6560 pin, 6600 pin, 6640 pin, 6680 pin, 6720 pin, 6760 pin, 6800 pin, 6840 pin, 6880 pin, 6920 pin, 6960 pin, 7000 pin, 7040 pin, 7080 pin, 7120 pin, 7160 pin, 7200 pin, 7240 pin, 7280 pin, 7320 pin, 7360 pin, 7400 pin, 7440 pin, 7480 pin, 7520 pin, 7560 pin, 7600 pin, 7640 pin, 7680 pin, 7720 pin, 7760 pin, 7800 pin, 7840 pin, 7880 pin, 7920 pin, 7960 pin, 8000 pin, 8040 pin, 8080 pin, 8120 pin, 8160 pin, 8200 pin, 8240 pin, 8280 pin, 8320 pin, 8360 pin, 8400 pin, 8440 pin, 8480 pin, 8520 pin, 8560 pin, 8600 pin, 8640 pin, 8680 pin, 8720 pin, 8760 pin, 8800 pin, 8840 pin, 8880 pin, 8920 pin, 8960 pin, 9000 pin, 9040 pin, 9080 pin, 9120 pin, 9160 pin, 9200 pin, 9240 pin, 9280 pin, 9320 pin, 9360 pin, 9400 pin, 9440 pin, 9480 pin, 9520 pin, 9560 pin, 9600 pin, 9640 pin, 9680 pin, 9720 pin, 9760 pin, 9800 pin, 9840 pin, 9880 pin, 9920 pin, 9960 pin, 10000 pin	

## MICROPROCESSORS! MEMORIES! SUPPORT!

Order by Cat. No. 3489 and type

8008	\$7.95	8289	19.95
8080A	9.95	2102-L1	\$1.59
8212	3.50	1103	.79
8214	7.95	MM5280	.99
8216	3.50	MM5281	.99
8224	3.50	MM5282	.99
8228	6.95	MM5283	.99
8238	7.95	MM5284	.99
8241	9.95	MM5285	.99
8253	19.95	MM5286	.99
8255	10.95	MM5287	.99
8257	19.95	MM5288	.99

## MINI TOGGLE SWITCHES

SALE! 3A 125VAC contacts or better!

\*Top USA makers!

Cat. No.	Contacts	Sale
4048	SPDT	89c
4049	SPDT	99c
4050	SPDT	1.29
4051	SPDT	1.49
4052	SPDT	1.69
4053	SPDT	1.89

\*center off

## LINEAR "POP" OP AMPS

Type	Each	Type	Each
LM3000	.49	LM3504	.99
LM3001	.49	LM3505	.99
LM3002	.49	LM3506	.99
LM3003	.49	LM3507	.99
LM3004	.49	LM3508	.99
LM3005	.49	LM3509	.99
LM3006	.49	LM3510	.99
LM3007	.49	LM3511	.99
LM3008	.49	LM3512	.99
LM3009	.49	LM3513	.99
LM3010	.49	LM3514	.99
LM3011	.49	LM3515	.99
LM3012	.49	LM3516	.99
LM3013	.49	LM3517	.99
LM3014	.49	LM3518	.99
LM3015	.49	LM3519	.99
LM3016	.49	LM3520	.99
LM3017	.49	LM3521	.99
LM3018	.49	LM3522	.99
LM3019	.49	LM3523	.99
LM3020	.49	LM3524	.99

## DIODES/ZENERS

1N914	100v	10mA	.05
1N4005	600v	1A	.08
1N4007	1000v	1A	.15
1N4148	75v	10mA	.05
1N4733	5.1v	1 W Zener	.25
1N753A	6.2v	500 mW Zener	.25
1N758A	10v	"	.25
1N759A	12v	"	.25
1N5243	13v	"	.25
1N5244B	14v	"	.25
1N5245B	15v	"	.25

## SOCKETS/BRIDGES

8-pin	pcb	.20	ww	.35
14-pin	pcb	.20	ww	.40
16-pin	pcb	.20	ww	.40
18-pin	pcb	.25	ww	.75
22-pin	pcb	.35	ww	.95
24-pin	pcb	.35	ww	.95
28-pin	pcb	.45	ww	1.25
40-pin	pcb	.50	ww	1.25
Molex pins	.01	To-3 Sockets		.25
2 Amp Bridge		100-prv		.95
25 Amp Bridge		200-prv		1.95

## TRANSISTORS, LEDS, etc.

2N2222	NPN (2N2222 Plastic .10)	.15
2N2907	PNP	.15
2N3906	PNP (Plastic - Unmarked)	.10
2N3904	NPN (Plastic - Unmarked)	.10
2N3054	NPN	.35
2N3055	NPN 15A 60v	.50
T1P125	PNP Darlington	.95
LED Green, Red, Clear, Yellow		.15
D.L.747	7 seg 5/8" High com-anode	1.95
MAN72	7 seg com-anode (Red)	1.25
MAN3610	7 seg com-anode (Orange)	1.25
MAN82A	7 seg com-anode (Yellow)	1.25
MAN74A	7 seg com-cathode (Red)	1.50
FND359	7 seg com-cathode (Red)	1.25

## C MOS

4000	.15
4001	.15
4002	.20
4004	3.95
4006	.95
4007	.20
4008	.75
4009	.35
4010	.35
4011	.20
4012	.20
4013	.40
4014	.75
4015	.75
4016	.35
4017	.75
4018	.75
4019	.35
4020	.85
4021	.75
4022	.75
4023	.20
4024	.75
4025	.20
4026	1.95
4027	.35
4028	.75
4030	.35
4033	1.50
4034	2.45
4035	.75
4040	.75
4041	.69
4042	.65
4043	.50
4044	.65
4046	1.25
4049	.45
4050	.45
4066	.55
4069/74 C04	.25
4071	.25
4081	.30
4082	.30
MC 14409	14.50
MC 14419	4.85
4511	.95
74C151	1.90

## 9000 SERIES

9301	.85	95H03	1.10
9309	.35	9601	.20
9322	.65	9602	.45

## MICRO'S, RAMS, CPU'S, E-PROMS

74S188	3.00	8214	8.95
1702A	4.50	8224	3.25
MM5314	3.00	8228	6.00
MM5316	3.50	8251	8.50
2102-1	1.45	8255	8.50
2102L-1	1.75	8T13	1.50
2114	9.50	8T23	1.50
TR1602B	3.95	8T24	2.00
TMS 4044-	9.95	8T97	1.00
		2107B-4	4.95
8080	8.95	2708	9.50
8212	2.95	Z80 PIO	8.50

## - T T L -

7473	.25	74176	.85
7474	.30	74180	.55
7475	.35	74181	2.25
7476	.40	74182	.75
7480	.55	74190	1.25
7481	.75	74191	.95
7483	.75	74192	.75
7485	.55	74193	.85
7486	.25	74194	.95
7489	1.05	74195	.95
7490	.45	74196	.95
7491	.70	74197	.95
7492	.45	74198	1.45
7493	.35	74221	1.00
7494	.75	74367	.75
7495	.60		
7496	.80	75108A	.35
74100	1.15	75491	.50
74107	.25	75492	.50
74121	.35		
74122	.55		
74123	.35	74H00	.15
74125	.45	74H01	.20
74126	.35	74H04	.20
74132	.75	74H05	.20
74141	.90	74H08	.35
74150	.85	74H10	.35
74151	.65	74H11	.25
74153	.75	74H15	.45
74154	.95	74H20	.25
74156	.70	74H21	.25
74157	.65	74H22	.40
74161	.55	74H30	.20
74163	.85	74H40	.25
74164	.60	74H50	.25
74165	1.10	74H51	.25
74166	1.25	74H52	.15
74175	.80	74H53J	.25
		74H55	.20

74H72	.35	74S133	.40
74H101	.75	74S140	.55
74H103	.55	74S151	.30
74H106	.95	74S153	.35
		74S157	.75
74L00	.25	74S158	.30
74L02	.20	74S194	1.05
74L03	.25	74S257 (8123)	1.05
74L04	.30		
74L10	.20	74LS00	.20
74L20	.35	74LS01	.20
74L30	.45	74LS02	.20
74L47	1.95	74LS04	.20
74L51	.45	74LS05	.25
74L55	.65	74LS08	.25
74L72	.45	74LS09	.25
74L73	.40	74LS10	.25
74L74	.45	74LS11	.25
74L75	.55	74LS20	.20
74L93	.55	74LS21	.25
74L123	.85	74LS22	.25
		74LS32	.25
74S00	.35	74LS37	.25
74S02	.35	74LS38	.35
74S03	.25	74LS40	.30
74S04	.25	74LS42	.65
74S05	.35	74LS51	.35
74S08	.35	74LS74	.35
74S10	.35	74LS86	.35
74S11	.35	74LS90	.55
74S20	.25	74LS93	.55
74S40	.20	74LS107	.40
74S50	.20	74LS123	1.00
74S51	.25	74LS151	.75
74S64	.15	74LS153	.75
74S74	.35	74LS157	.75
74S112	.60	74LS164	1.00
74S114	.65	74LS193	.95
		74LS367	.75
		74LS368	.65

## MCT2 .95

8038	3.95
LM201	.75
LM301	.45
LM308 (Mini)	.95
LM309H	.65
LM309K (340K-5)	.85
LM310	.85
LM311D (Mini)	.75
LM318 (Mini)	1.75
LM320K5 (/9051)	.65
LM320K12	1.65

## LINEARS, REGULATORS, etc.

LM320T5	1.65	LM340K15	1.25
LM320T12	1.65	LM340K18	1.25
LM320T15	1.65	LM340K24	1.25
LM324N	1.25	78L05	.75
LM339	.75	78L12	.75
7805 (340T5)	.95	78L15	.75
LM340T12	.95	78M05	.75
LM340T15	.95	LM373	2.95
LM340T18	.95	LM380 (8-14 PIN)	.95
LM340T24	.95	LM709 (8, 14 PIN)	.25
LM340K12	1.25	LM711	.45

LM723	.40
LM725N	2.50
LM739	1.50
LM741 (8-14)	.25
LM747	1.10
LM1307	1.25
LM1458	.65
LM3900	.50
LM75451	.65
NE555	.35
NE556	.85
NE565	.95
NE566	1.25
NE567	.95

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### INTEGRATED CIRCUITS

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For free catalog including parts lists and schematics, send a self-addressed stamped envelope.

## APPLE II SERIAL I/O INTERFACE \*

Part no. 2

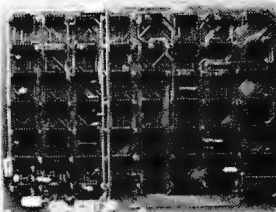
Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer. • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some electrics. Board only — \$15.00; with parts — \$42.00; assembled and tested — \$62.00.



## T.V. TYPEWRITER

Part no. 106

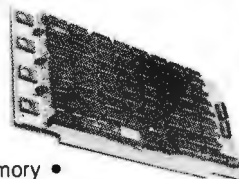
• Stand alone TVT • 32 char/line, 16 lines, modifications for 64 char/line included • Parallel ASCII (TTL) input • Video output • 1K on board memory • Output for computer controlled cursor • Auto scroll • Non-destructive cursor • Cursor inputs: up, down, left, right, home, EOL, EOS • Scroll up, down • Requires +5 volts at 1.5 amps, and -12 volts at 30 mA • All 7400, TTL chips • Char. gen. 2513 • Upper case only • Board only \$39.00; with parts \$145.00



## 8K STATIC RAM

Part no. 300

• 8K Altair bus memory • Uses 2102 Static memory chips • Memory protect • Gold contacts • Wait states • On board regulator • S-100 bus compatible • Vector input option • TRI state buffered • Board only \$27.50; with parts \$160.00



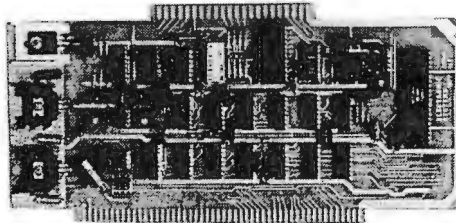
## MODEM \*

Part no. 109

• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • No coils, only low cost components • TTL input and output-serial • Connect 8 ohm speaker and crystal mic. directly to board • Uses XR FSK demodulator • Requires +5 volts • Board \$7.60; with parts \$27.50



## TIDMA \*



Part no. 112

• Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate. • S-100 bus compatible • Board only \$35.00; with parts \$110.00

## DC POWER SUPPLY \*

Part no. 6085

• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts A.C.T. at 1.5 amps. • Board only \$12.50; with parts excluding transformers \$42.50



## TAPE INTERFACE \*

Part no. 111

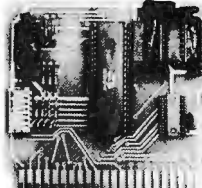
• Play and record Kansas City Standard tapes • Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL-serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board \$7.60; with parts \$27.50



## UART & BAUD RATE GENERATOR \*

Part no. 101

• Converts serial to parallel and parallel to serial • Low cost on board baud rate generator • Baud rates: 110, 150, 300, 600, 1200, and 2400 • Low power drain +5 volts and -12 volts required • TTL compatible • All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. • All connections go to a 44 pin gold plated edge connector • Board only \$12.00; with parts \$35.00 with connector add \$3.00



## RS 232/TTY \*

Part no. 600

• Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232 • Two separate circuits • Requires -12 and +12 volts • Board only \$4.50, with parts \$7.00



## RS 232/TTL \*

Part no. 232

• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin gold plated edge connector • Board only \$4.50; with parts \$7.00 with connector add \$2.00



# ELECTRONIC SYSTEMS

Dept. PE, P.O. Box 21638, San Jose, CA. USA 95151

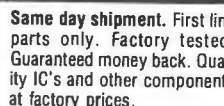
## To Order:

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\* Circuits designed by John Bell





## ELECTRONICS

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64K Dynamic RAM Kit	945.00
8K/16K Eprom Kit (less PROMS)	<b>\$89.00</b>
Video Interface Kit	<b>\$139.00</b>
Motherboard <b>\$39.</b>	Extender Board <b>\$8.99</b>

**NLS 15 Megahertz PORTABLE MINI-SCOPES**

DUAL TRACE MS-215 \$435.00  
SINGLE TRACE MS-15 \$318.00

with RECHARGEABLE BATTERIES & CHARGER

PORTABLE (2.7"Hx6.4"Wx7.5"D)  
AVAILABLE OPTIONS - usable on both the MS-215 and the MS-15  
41-140 Leather Carrying Case \$45.00 - 41-141 10 to 1 Probe \$24.50

DIP SWITCHES	J58722-03 \$1.40	J58722-07 \$1.85
SPST SLIDE TYPE	J58722-04 1.70	J58722-08 1.95
J58722-01 \$1.00	J58722-05 1.75	J58722-09 2.00
J58722-02 1.08	J58722-06 1.80	J58722-10 2.20

Dash No. indicates number of switch positions on DIP Switch.

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mid	10 volt	16 volt	25 volt	35 volt	50 volt
1	8/51.00	7/51.00	7/51.00	7/51.00	6/51.00
4	7/51.00	7/51.00	6/51.00	6/51.00	4/51.00
10	7/51.00	7/51.00	6/51.00	5/51.00	4/51.00
22	7/51.00	6/51.00	5/51.00	4/51.00	3/51.00
33	6/51.00	6/51.00	4/51.00	4/51.00	4/51.00
47	6/51.00	5/51.00	4/51.00	4/51.00	3/51.00
100	5/51.00	5/51.00	4/51.00	4/51.00	3/51.00
220	4/51.00	4/51.00	3/51.00	3/51.00	2/51.00
330	4/51.00	3/51.00	3/51.00	2/51.00	2/51.00
470	3/51.00	3/51.00	2/51.00	2/51.00	1/51.00
1000	---	---	2/51.25	\$ 80	\$ 1.20
2200	---	---	\$1.30	\$1.60	\$2.50

**50 VOLT CERAMIC DISC CAPACITORS**

pl	Qty	pl	Qty	mid	Qty	mid	Qty
5	9/pk	220	7/pk	001	9/pk	015	8/pk
15	9/pk	270	7/pk	0015	9/pk	02	8/pk
25	9/pk	300	7/pk	0022	9/pk	022	8/pk
33	9/pk	330	7/pk	003	9/pk	03	8/pk
47	8/pk	390	7/pk	0047	9/pk	039	7/pk
68	8/pk	470	7/pk	0068	9/pk	047	7/pk
100	8/pk	560	7/pk	01	9/pk	068	7/pk
150	8/pk	880	7/pk	---	---	---	---

**1-9 & 10 up 100up**

**Microprocessor & Support ICs**

AD9201 ADC	24.90	20.15	15.50
CM8080A	11.20	9.60	8.00
P8080A	5.95	5.10	4.25
CM8085A	26.75	23.00	19.25
P8085A	22.10	19.00	16.25
DB212	4.40	3.85	3.30
DB212	3.26	2.85	2.44
DB216	4.20	3.67	3.15
DB216	3.06	2.68	2.29
DB224	4.50	4.00	3.50
AM8224PC	4.00	3.50	3.00
DB226	4.20	3.67	3.15
DB226	3.06	2.68	2.29
DB228	3.06	2.68	2.29
AM8228PC	7.00	6.00	5.00
DB238	8.00	7.00	6.00
AM8238PC	7.00	6.12	5.25
DB251	11.20	9.60	8.00
DB251	5.95	5.10	4.25
DB255	10.25	8.75	7.30
DB255	5.60	4.80	4.00
AM8257PC	14.35	12.30	10.25

**VIDEO DISPLAY CONTROLLER**

1-24	25 up	100up
CRT8002A	35.00	29.00 27.60

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LM101H	1.85	1.32 1.10
LM101AH	1.80	1.44 1.20
LM105H	4.85	3.90 3.25
LM106H	4.80	3.80 3.20
LM107H	2.10	1.60 1.40
LM109H	7.00	4.50 3.90
LM110H	6.00	4.80 4.00
LM111H	4.50	3.60 3.00
LM114	4.50	3.60 3.00
LM115H	12.75	10.80 9.15
LM124D	3.23	2.58 2.10
LM200H	6.00	4.80 4.00
LM201H	1.80	.86 .72
LM201AN(14)	1.95	1.55 1.10
LM202H	7.00	4.50 3.90
LM205H	5.50	4.40 3.70
LM206H	4.25	3.40 2.85
LM208H	6.00	4.80 4.00
LM209H	3.00	2.50 2.10
LM209H	3.25	2.75 2.45
LM210H	6.00	4.80 4.00
LM211H	3.45	2.75 2.30
LM211N(8)	5.50	4.60 3.65
LM218H	10.50	8.50 7.10
LM300H	2.70	2.15 1.80
LM301AH	.95	.78 .65
LM301AJ	1.25	.98 .83
LM302D	4.35	3.45 2.90
LM302H	4.00	3.20 2.65
LM304H	3.25	2.58 2.15
LM305H	1.45	1.15 .90
LM306H	1.80	1.40 1.20
LM307H	.90	.72 .60
LM307N(8)	80	64 53
LM307N(14)	90	72 60
LM308H	1.28	1.02 .85
LM308AH	5.10	4.40 3.40
LM308AD	6.75	5.40 4.40
LM308AN(8)	4.50	3.60 3.00
LM308D	3.45	2.75 2.30
LM308N(8)	.85	.68 .57
LM309H	1.05	.84 .70
LM309K	2.40	2.00 1.40
LM310H	2.65	2.00 1.70
LM310D	4.00	3.85 3.20
LM310N(8)	2.00	1.55 1.34
LM311D	5.50	3.90 3.20
LM311H	1.05	.84 .70
LM311N(8)	1.05	.84 .70
LM312H	3.53	2.82 2.35
LM315H	6.45	5.15 4.30
LM317H	3.45	2.95 2.00
LM317K	3.95	3.15 2.35
LM318H	3.38	2.70 2.25
LM318N(8)	3.00	2.40 2.00
LM319H	2.85	2.25 1.90
LM319N(14)	2.48	1.98 1.65
LM324D	1.58	1.25 1.00
LM324N(14)	1.50	1.20 1.00
LM339AD	3.00	2.40 2.00

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**MODEL 303 Complete w/Probes and Ni-cad Bat. \$895.00**

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ICL7106CP	14.70	11.75	9.50	2525V	3.55	2.25	1.95
ICL7107CP	13.85	11.10	9.25	2535V	3.55	2.25	1.95
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NUMBER	Vdc Amps	NUMBER	Vdc Amps
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INTEGRATED CIRCUITS

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1803LD	5.65	4.80	4.45	1803LE	1.45	1.40	1.15
1804LD	11.70	11.00	9.20	1804LE	8.50	8.00	6.85
1805LD	5.50	4.75	4.30	1805LE	1.10	1.05	.87
1806LD	5.50	4.75	4.30	1806LE	1.10	1.05	.87
1808LD	5.65	4.90	4.45	1808LE	1.45	1.40	1.15
1809LD	5.65	4.90	4.45	1809LE	1.45	1.40	1.15

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Fully Assembled - Features KIM-1 hardware compatibility - 28 Double Function keypad (w/audio response) - 8-Digit HEX display - 3 on board programmable interval timers - 4K byte ROM-resident monitor - 1K byte 2114 static RAM (expandable to 4K bytes on board) - 3 PROM/ROM expansion sockets for 2315/2323/2716 EPROMs  
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**Soft-Touch TONE DIALER**  
● Convert standard rotary phones into Touch-Tone.  
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● Utilize for tone signaling, also.  
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EACH SET CONTAINS 840 RESISTORS - 20 each of the following values (in ohms): .68, 1, 1.5, 2.2, 3.3, 4.7, 6.8, 10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680, 1K, 1.5K, 2.2K, 3.3K, 4.7K, 6.8K, 10K, 15K, 22K, 33K, 47K, 68K, 100K, 150K, 220K, 330K, 470K, 680K, 1M, 1.5M, 2.2M, 3.3M, and 4.7M  
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120	1.2K	12K	120K	1.2M
130	1.3K	13K	130K	1.3M
150	1.5K	15K	150K	1.5M
160	1.6K	16K	160K	1.6M
180	1.8K	18K	180K	1.8M
200	2.0K	20K	200K	2.0M
220	2.2K	22K	220K	2.2M
240	2.4K	24K	240K	2.4M
270	2.7K	27K	270K	2.7M
300	3.0K	30K	300K	3.0M
330	3.3K	33K	330K	3.3M
360	3.6K	36K	360K	3.6M
390	3.9K	39K	390K	3.9M
430	4.3K	43K	430K	4.3M
470	4.7K	47K	470K	4.7M
510	5.1K	51K	510K	5.1M
560	5.6K	56K	560K	5.6M
620	6.2K	62K	620K	6.2M
680	6.8K	68K	680K	6.8M
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4002	-18	4020	-39	4050	-35	74C74	-45
4005	-95	4021	-90	4053	-1.25	74C83	-1.15
4007	-18	4022	-90	4055	-1.25	74C86	-40
4009	-37	4023	-18	4056	-70	74C93	-75
4010	-38	4024	-75	4071	-18	74C151	1.40
4011	-18	4025	-37	4072	-97	74C160	1.05
4012	-18	4026	-37	4073	-22	74C174	1.05
4013	-75	4029	-95	74C02	-22	74C175	1.05
4014	-75	4030	-33	74C04	-24	74C193	1.20
4015	-75	4031	-33	74C08	-24	74C901	48
4016	-29	4032	-33	74C09	-24	74C902	48
4017	-90	4042	-65	74C10	-25	74C914	1.70
4018	-90	4046	-1.35	74C42	-85		

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CTS 206-8 eight position dip switch	...\$1.60
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TO 18, 200V 1A	...\$ .70

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BOARD 1 1/8" thick, unetched  
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100, 1K, 2K, 5K, 10K, 20K, 50K, 100K,  
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This board is a 1/16" single sided paper epoxy board, 4 1/2" x 6 1/2" DRILLED AND ETCHED which will hold up to 21 single 14 pin IC's or 8, 16 or LSI DIP IC's with busses for power supply connector.

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LARGE LED'S 2"	6/\$1.00
TIL-18 OPTO-ISOLATOR	\$ .75
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	1000/\$8.00

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6/\$1.00  
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400	09	25	50	140	650	9.50
600	11	30	70	180	850	12.50
800	15	35	90	230	1050	16.50
1000	20	45	110	275	1250	20.00

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IN 4148 (1N914) ... \$15.00

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D8 25S female	...\$2.95
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320T-12, 15		or 24V	\$1.25
or 24V	\$1.25	78 MG	...\$1.35
		79 MG	...\$1.35

# TRANSISTOR SPECIALS

2N6233 NPN SWITCHING POWER	\$ .95
MRF-8004 CB RF Transistor NPN	\$ .75
2N3772 PNP Si TO 3	\$ 1.00
2N1546 PNP GE TO 3	...\$ .75
2N4908 PNP Si TO 3	\$ 1.00
2N8056 NPN Si TO 3 Darlington	\$ 1.70
2N8056 NPN Si TO 92	4 \$ 1.00
2N3137 NPN Si RF	...\$ .95
2N3919 NPN Si TO 3 RF	...\$ 1.50
2N1420 NPN Si TO 5	3/\$ 1.00
2N3767 NPN Si TO 65	\$ .70
2N2222 NPN Si TO 18	5 \$ 1.00
2N3055 NPN Si TO 3	\$ .80
2N3904 NPN Si TO 92	6/\$ 1.00
2N3906 PNP Si TO 92	6/\$ 1.00
2N5206 NPN Si TO 730	...\$ .50
2N6109 PNP Si TO 230	\$ .55
2N3638 PNP Si TO 5	5 \$ 1.00
MPSA 13 NPN Si	4/\$ 1.00

# TLI IC SERIES

7400	-13	7445	-65	74151	-81
7401	-13	7446	-68	74152	-81
7402	-13	7447	-68	74153	-81
7403	-13	7448	-68	74154	-81
7404	-15	7450	-15	74155	-81
7405	-13	7472	-25	74156	-81
7406	-16	7473	-28	74157	-81
7407	-20	7474	-28	74158	-81
7408	-18	7475	-45	74159	-81
7409	-18	7476	-30	74160	-81
7410	-13	7477	-31	74161	-81
7411	-18	7483	-65	74162	-81
7412	-13	7485	-87	74163	-81
7413	-36	7486	-87	74164	-81
7414	-60	7489	-125	74165	-81
7415	-22	7490	-42	74166	-81
7416	-22	7491	-58	74167	-81
7417	-25	7492	-43	74168	-81
7420	-13	7493	-43	74169	-81
7425	-25	7494	-67	74170	-81
7426	-22	7495	-65	74171	-81
7427	-18	7496	-65	74172	-81
7430	-13	7497	-65	74173	-81
7432	-22	7498	-67	74174	-81
7437	-21	7499	-67	74175	-81
7438	-21	7500	-67	74176	-81
7440	-13	7501	-67	74177	-81
7441	-70	7502	-67	74178	-81
7442	-37	7503	-67	74179	-81

# DATA CASSETTES 1/2 HR \$ .95

22/44 Pin Solder Tail .156" Conn. \$1.95

# MM 5387AA new clock chip which will directly drive LED's 12/24 hrs. 1 supply & alarm \$5.95

# NO. 30 WIRE WRAPE WIRE SINGLE STRAND 100' \$1.40

# ALCO MINIATURE TOGGLE SWITCHES

MTA 106 SPDT	\$ .95
MTA 206 P-PPDT CENTER OFF	\$ 1.70
MSD 206 P-PPDT CENTER OFF	\$ 1.85
LEVER SWITCH	...\$ 1.85

# Full Wave Bridges

PRV	2A	6A	25A
100			1.30
200	.75	1.25	2.00
400	.95	1.50	3.00
600	1.20	1.75	4.00

# DIP SOCKETS

8 PIN .17 24 PIN .35	
14 PIN .20 28 PIN .40	
16 PIN .22 40 PIN .60	
18 PIN .25	

# SANKEN AUDIO POWER AMPS

Si 1010 G 10 WATTS	...\$ 7.80
Si 1020 G 20 WATTS	...\$15.70
Si 1050 G 50 WATTS	...\$28.50

# TANTULUM CAPACITORS

22UF 35V 5 \$1.00	68UF 35V 4 \$1.00
47UF 35V 5 \$1.00	100UF 10V \$ .25
68UF 35V 5 \$1.00	22UF 25V \$ .40
10UF 35V 5 \$1.00	15UF 35V 3/\$1.00
22UF 20V 4 \$1.00	30UF 6V \$1.00
33UF 20V 4 \$1.00	47UF 20V \$ .35
47UF 15V 5/\$1.00	68UF 15V \$ .40
	100UF 10V \$ .50

# 74LS SERIES

74LS SERIES			
74LS00	-19	74LS122	-70
74LS01	-19	74LS123	-70
74LS02	-19	74LS124	-70
74LS03	-19	74LS125	-70
74LS04	-21	74LS126	-70
74LS05	-21	74LS127	-70
74LS06	-21	74LS128	-70
74LS07	-21	74LS129	-70
74LS08	-21	74LS130	-70
74LS09	-21	74LS131	-70
74LS10	-21	74LS132	-70
74LS11	-21	74LS133	-70
74LS12	-21	74LS134	-70
74LS13	-21	74LS135	-70
74LS14	-21	74LS136	-70
74LS15	-21	74LS137	-70
74LS16	-21	74LS138	-70
74LS17	-21	74LS139	-70
74LS18	-21	74LS140	-70
74LS19	-21	74LS141	-70
74LS20	-21	74LS142	-70
74LS21	-21	74LS143	-70
74LS22	-21	74LS144	-70
74LS23	-21	74LS145	-70
74LS24	-21	74LS146	-70
74LS25	-21	74LS147	-70
74LS26	-21	74LS148	-70
74LS27	-21	74LS149	-70
74LS28	-21	74LS150	-70
74LS29	-21	74LS151	-70
74LS30	-21	74LS152	-70
74LS31	-21	74LS153	-70
74LS32	-21	74LS154	-70
74LS33	-21	74LS155	-70
74LS34	-21	74LS156	-70
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74LS37	-21	74LS159	-70
74LS38	-21	74LS160	-70
74LS39	-21	74LS161	-70
74LS40	-21	74LS162	-70
74LS41	-21	74LS163	-70
74LS42	-21	74LS164	-70
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74LS44	-21	74LS166	-70
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74LS279	-21	74LS401	-70
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74LS302	-21	74LS424	-70
74LS303	-21	74LS425	-70
74LS304	-21	74LS426	-70
74LS305	-21	74LS427	-70
74LS306	-21	74LS428	-70
74LS307	-21	74LS429	-70
74LS308	-21	74LS430	-70
74LS309	-21	74LS431	-70
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74LS311	-21	74LS4	

# FORDHAM

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### 100 MHz 8-Digit Counter

• 20 Hz 100 MHz Range • 6" LED Display • Fully Automatic  
• Includes 100 IPC clip-lead input cable, manual \$119.00



Model MAX-100

### BK PRECISION 3 1/2-Digit

#### Portable DMM

• Overhead Protected • Battery or AC operation • 3" high LED Display  
• Auto Zeroing Model 2800  
comes complete with test leads, operating manual and spare fuses

\$85



### TEICO 3 1/2 Digit DMM

• Flashing Over Range Indicator  
• Auto Polarity • Overload Protected  
Model 270 wired Reg \$80.00  
Kit \$65.00



### RCA Color Generator

Reg. \$89.50 \$59.95 MODEL WR 508



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• Add, subtract modes on CH 1 & CH 2  
• Front panel X-Y operation  
• 17.5 nSec rise time  
Reg. \$769.95 \$654.50 with accessories



### Transistor Tester

9 volt battery included  
• Moveable base pin terminals to T.O.S., T.O. 18 and small "in line" leads  
• Tests transistors in or out of circuit • Operates on contact  
• Clear speaker tone, no visual observations to make  
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#### Tool Cases

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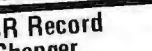
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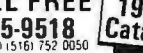
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20 oz. ceramic magnet \$14.95



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### FREE 1978 Catalog



### FORDHAM

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CIRCLE NO. 17 ON FREE INFORMATION CARD

# THE ECONORAM FAMILY OF MEMORIES... they're static, they're cost-effective, they work.

Now most Econorams are available as "unkits" (sockets, bypass caps pre-soldered in place for easy assembly) or assembled and qualified under the Certified System Components program (CSC boards are burned in for 200 hours, tested, serial numbered, and guaranteed to run at 4 MHz over the full temperature range. We exchange board if failure occurs within 1 year of invoice date).

All Econorams handle DMA devices and feature full buffering, static design, low power/high speed operation, and specialty features too numerous to mention here along with a 1 year limited warranty. For more information, request our free flyer.

**8K ECONORAM II:** Use with any S-100 machine. Dual block configuration. Kit \$135, 3 kits \$375, assembled/tested \$155.

**12K ECONORAM VI:** Brings Econoram quality to the Heath H8 buss. Unkit \$235, SPECIAL - 2 unkits \$399, assem/tested \$270.

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**ALL OF THE ABOVE ARE AVAILABLE FROM STOCK.** Coming soon: 32K boards for the S-100 buss, the Intel/National 80/10 and 80/20 machines, and the Digital Group... plus an S-100 dual USART I/O board and our new family of S-100 PROM boards. Write for price and availability, or better yet, visit your local computer store as they should have information by the time this appears in print.

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Our Conversion Kit contains all parts (and detailed instructions) necessary to upgrade a 4K TRS-80 mainframe to 16K, or populate the Memory Expansion Module. Also works with APPLes. Only \$159 (3kits/\$450)... and we back up our parts with a 1 year warranty.

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\$44.50

Handles 12A with 50% duty cycle. Ideal for powering mobile equipment in the home. Crowbar overvoltage protection, foldback current limiting, adjustable output 11-14V, custom wound heavy-duty transformer, RF suppression, easy assembly (all parts except xfrmtr/filter caps/diodes mount on circuit board). Case not included. With full assembly instructions.

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Add 3 time-setting switches, 12V DC, and you're up and running. Ideal for car, van, other mobile applications thanks to xtal-controlled timebase. Large (0.3") blue-green fluorescent readouts. Includes custom options for car applications (automatic dimming when headlights are turned on, etc.). Whether you need a clock yourself or want to present someone with a fine gift, this is an excellent choice. With applications data. 3/\$46.

**FREE FLYER:** Our 40 page flyer lists bargain after bargain. Send us your name and address, we'll take care of the rest.

**TERMS:** Cal res add tax. Allow 5% shipping. (more for power supply) excess refunded. COD OK with street address for UPS. VISA/Mastercharge call 24 hr. order desk at (415) 562-0636. Thanks for your business.

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# PRIME TTL & CMOS AT LOWEST PRICES

## 74xx TTL

7400	...	\$0.14
7401	...	0.15
7402	...	0.15
7403	...	0.15
7404	...	0.16
7405	...	0.16
7406	...	0.24
7407	...	0.24
7408	...	0.17
7409	...	0.17
7410	...	0.15
7411	...	0.18
7412	...	0.20
7413	...	0.25
7414	...	0.55
7416	...	0.22
7417	...	0.22
7420	...	0.15
7421	...	0.17
7423	...	0.25
7425	...	0.25
7426	...	0.22
7427	...	0.19
7430	...	0.15
7432	...	0.23
7433	...	0.21
7438	...	0.21
7439	...	0.25
7440	...	0.15
7441	...	0.70
7442	...	0.38
7443	...	0.55
7444	...	0.55
7445	...	0.55
7446	...	0.62
7447	...	0.57
7448	...	0.60
7450	...	0.15
7451	...	0.15
7453	...	0.15
7454	...	0.15
7459	...	0.15
7460	...	0.15
7470	...	0.27
7472	...	0.24
7473	...	0.24
7474	...	0.24
7475	...	0.45
7476	...	0.29

## 74LSxx TTL

74LS00	...	\$0.21
74LS01	...	0.27
74LS02	...	0.21
74LS03	...	0.21
74LS04	...	0.24
74LS05	...	0.24
74LS08	...	0.23
74LS09	...	0.23
74LS10	...	0.21
74LS11	...	0.21
74LS12	...	0.27
74LS13	...	0.40
74LS14	...	0.85
74LS15	...	0.26
74LS16	...	0.26
74LS17	...	0.26
74LS18	...	0.26
74LS19	...	0.26
74LS20	...	0.26
74LS21	...	0.26
74LS22	...	0.26
74LS23	...	0.26
74LS24	...	0.26
74LS25	...	0.26
74LS26	...	0.26
74LS27	...	0.26
74LS28	...	0.26
74LS29	...	0.26
74LS30	...	0.26
74LS31	...	0.26
74LS32	...	0.26
74LS33	...	0.26
74LS34	...	0.26
74LS35	...	0.26
74LS36	...	0.26
74LS37	...	0.26
74LS38	...	0.26
74LS39	...	0.26
74LS40	...	0.26

## 74Sxx TTL

74S00	...	\$0.35
74S01	...	0.35
74S02	...	0.35
74S03	...	0.35
74S04	...	0.35
74S05	...	0.35
74S08	...	0.35
74S09	...	0.35
74S10	...	0.35
74S11	...	0.35
74S12	...	0.35
74S13	...	0.35
74S14	...	0.35
74S15	...	0.35
74S16	...	0.35
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74S18	...	0.35
74S19	...	0.35
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74S33	...	0.35
74S34	...	0.35
74S35	...	0.35
74S36	...	0.35
74S37	...	0.35
74S38	...	0.35
74S39	...	0.35
74S40	...	0.35

## 74Cxx TTL

74C00	...	\$0.24
74C01	...	0.24
74C02	...	0.24
74C03	...	0.24
74C04	...	0.24
74C05	...	0.24
74C08	...	0.24
74C09	...	0.24
74C10	...	0.24
74C11	...	0.24
74C12	...	0.24
74C13	...	0.24
74C14	...	0.24
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74C35	...	0.24
74C36	...	0.24
74C37	...	0.24
74C38	...	0.24
74C39	...	0.24
74C40	...	0.24

## 4xxx CMOS

4000	...	\$0.16
4001	...	0.16
4002	...	0.16
4003	...	0.16
4004	...	0.16
4005	...	0.16
4008	...	0.16
4009	...	0.16
4010	...	0.16
4011	...	0.16
4012	...	0.16
4013	...	0.16
4014	...	0.16
4015	...	0.16
4016	...	0.16
4017	...	0.16
4018	...	0.16
4019	...	0.16
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4093	...	0.16
4094	...	0.16
4095	...	0.16
4096	...	0.16
4097	...	0.16
4098	...	0.16
4099	...	0.16
4100	...	0.16

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Sorry, but at this price, we must limit each order to only two systems per customer.

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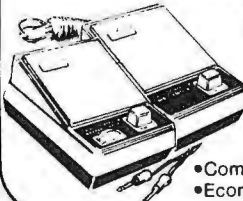
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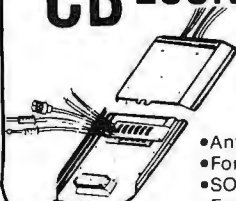
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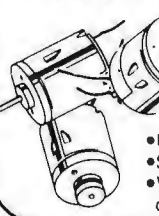
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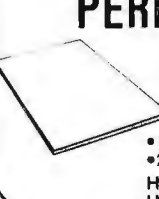
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25A200	.35	25B840	.42	25C913	.62	25C1314	.35	25C98	.45	MM6004B	11.73
25A201	.35	25B841	.42	25C914	.62	25C1315	.35	25C98	.45	MM6004C	11.73
25A202	.35	25B842	.42	25C915	.62	25C1316	.35	25C98	.45	MM6004D	11.73
25A203	.35	25B843	.42	25C916	.62	25C1317	.35	25C98	.45	MM6004E	11.73
25A204	.35	25B844	.42	25C917	.62	25C1318	.35	25C98	.45	MM6004F	11.73
25A205	.35	25B845	.42	25C918	.62	25C1319	.35	25C98	.45	MM6004G	11.73
25A206	.35	25B846	.42	25C919	.62	25C1320	.35	25C98	.45	MM6004H	11.73
25A207	.35	25B847	.42	25C920	.62	25C1321	.35	25C98	.45	MM6004I	11.73
25A208	.35	25B848	.42	25C921	.62	25C1322	.35	25C98	.45	MM6004J	11.73
25A209	.35	25B849	.42	25C922	.62	25C1323	.35	25C98	.45	MM6004K	11.73
25A210	.35	25B850	.42	25C923	.62	25C1324	.35	25C98	.45	MM6004L	11.73
25A211	.35	25B851	.42	25C924	.62	25C1325	.35	25C98	.45	MM6004M	11.73
25A212	.35	25B852	.42	25C925	.62	25C1326	.35	25C98	.45	MM6004N	11.73
25A213	.35	25B853	.42	25C926	.62	25C1327	.35	25C98	.45	MM6004O	11.73
25A214	.35	25B854	.42	25C927	.62	25C1328	.35	25C98	.45	MM6004P	11.73
25A215	.35	25B855	.42	25C928	.62	25C1329	.35	25C98	.45	MM6004Q	11.73
25A216	.35	25B856	.42	25C929	.62	25C1330	.35	25C98	.45	MM6004R	11.73
25A217	.35	25B857	.42	25C930	.62	25C1331	.35	25C98	.45	MM6004S	11.73
25A218	.35	25B858	.42	25C931	.62	25C1332	.35	25C98	.45	MM6004T	11.73
25A219	.35	25B859	.42	25C932	.62	25C1333	.35	25C98	.45	MM6004U	11.73
25A220	.35	25B860	.42	25C933	.62	25C1334	.35	25C98	.45	MM6004V	11.73
25A221	.35	25B861	.42	25C934	.62	25C1335	.35	25C98	.45	MM6004W	11.73
25A222	.35	25B862	.42	25C935	.62	25C1336	.35	25C98	.45	MM6004X	11.73
25A223	.35	25B863	.42	25C936	.62	25C1337	.35	25C98	.45	MM6004Y	11.73
25A224	.35	25B864	.42	25C937	.62	25C1338	.35	25C98	.45	MM6004Z	11.73
25A225	.35	25B865	.42	25C938	.62	25C1339	.35	25C98	.45	MM6005	11.73
25A226	.35	25B866	.42	25C939	.62	25C1340	.35	25C98	.45	MM6005A	11.73
25A227	.35	25B867	.42	25C940	.62	25C1341	.35	25C98	.45	MM6005B	11.73
25A228	.35	25B868	.42	25C941	.62	25C1342	.35	25C98	.45	MM6005C	11.73
25A229	.35	25B869	.42	25C942	.62	25C1343	.35	25C98	.45	MM6005D	11.73
25A230	.35	25B870	.42	25C943	.62	25C1344	.35	25C98	.45	MM6005E	11.73
25A231	.35	25B871	.42	25C944	.62	25C1345	.35	25C98	.45	MM6005F	11.73
25A232	.35	25B872	.42	25C945	.62	25C1346	.35	25C98	.45	MM6005G	11.73
25A233	.35	25B873	.42	25C946	.62	25C1347	.35	25C98	.45	MM6005H	11.73
25A234	.35	25B874	.42	25C947	.62	25C1348	.35	25C98	.45	MM6005I	11.73
25A235	.35	25B875	.42	25C948	.62	25C1349	.35	25C98	.45	MM6005J	11.73
25A236	.35	25B876	.42	25C949	.62	25C1350	.35	25C98	.45	MM6005K	11.73
25A237	.35	25B877	.42	25C950	.62	25C1351	.35	25C98	.45	MM6005L	11.73
25A238	.35	25B878	.42	25C951	.62	25C1352	.35	25C98	.45	MM6005M	11.73
25A239	.35	25B879	.42	25C952	.62	25C1353	.35	25C98	.45	MM6005N	11.73
25A240	.35	25B880	.42	25C953	.62	25C1354	.35	25C98	.45	MM6005O	11.73
25A241	.35	25B881	.42	25C954	.62	25C1355	.35	25C98	.45	MM6005P	11.73
25A242	.35	25B882	.42	25C955	.62	25C1356	.35	25C98	.45	MM6005Q	11.73
25A243	.35	25B883	.42	25C956	.62	25C1357	.35	25C98	.45	MM6005R	11.73
25A244	.35	25B884	.42	25C957	.62	25C1358	.35	25C98	.45	MM6005S	11.73
25A245	.35	25B885	.42	25C958	.62	25C1359	.35	25C98	.45	MM6005T	11.73
25A246	.35	25B886	.42	25C959	.62	25C1360	.35	25C98	.45	MM6005U	11.73
25A247	.35	25B887	.42	25C960	.62	25C1361	.35	25C98	.45	MM6005V	11.73
25A248	.35	25B888	.42	25C961	.62	25C1362	.35	25C98	.45	MM6005W	11.73
25A249	.35	25B889	.42	25C962	.62	25C1363	.35	25C98	.45	MM6005X	11.73
25A250	.35	25B890	.42	25C963	.62	25C1364	.35	25C98	.45	MM6005Y	11.73
25A251	.35	25B891	.42	25C964	.62	25C1365	.35	25C98	.45	MM6005Z	11.73
25A252	.35	25B892	.42	25C965	.62	25C1366	.35	25C98	.45	MM6006	11.73
25A253	.35	25B893	.42	25C966	.62	25C1367	.35	25C98	.45	MM6006A	11.73
25A254	.35	25B894	.42	25C967	.62	25C1368	.35	25C98	.45	MM6006B	11.73
25A255	.35	25B895	.42	25C968	.62	25C1369	.35	25C98	.45	MM6006C	11.73
25A256	.35	25B896	.42	25C969	.62	25C1370	.35	25C98	.45	MM6006D	11.73
25A257	.35	25B897	.42	25C970	.62	25C1371	.35	25C98	.45	MM6006E	11.73
25A258	.35	25B898	.42	25C971	.62	25C1372	.35	25C98	.45	MM6006F	11.73
25A259	.35	25B899	.42	25C972	.62	25C1373	.35	25C98	.45	MM6006G	11.73
25A260	.35	25B900	.42	25C973	.62	25C1374	.35	25C98	.45	MM6006H	11.73
25A261	.35	25B901	.42	25C974	.62	25C1375	.35	25C98	.45	MM6006I	11.73
25A262	.35	25B902	.42	25C975	.62	25C1376	.35	25C98	.45	MM6006J	11.73
25A263	.35	25B903	.42	25C976	.62	25C1377	.35	25C98	.45	MM6006K	11.73
25A264	.35	25B904	.42	25C977	.62	25C1378	.35	25C98	.45	MM6006L	11.73
25A265	.35	25B905	.42	25C978	.62	25C1379	.35	25C98	.45	MM6006M	11.73
25A266	.35	25B906	.42	25C979	.62	25C1380	.35	25C98	.45	MM6006N	11.73
25A267	.35	25B907	.42	25C980	.62	25C1381	.35	25C98	.45	MM6006O	11.73
25A268	.35	25B908	.42	25C981	.62	25C1382	.35	25C98	.45	MM6006P	11.73
25A269	.35	25B909	.42	25C982	.62	25C1383	.35	25C98	.45	MM6006Q	11.73
25A270	.35	25B910	.42	25C983	.62	25C1384	.35	25C98	.45	MM6006R	11.73
25A271	.35	25B911	.42	25C984	.62	25C1385	.35	25C98	.45	MM6006S	11.73
25A272	.35	25B912	.42	25C985	.62	25C1386	.35	25C98	.45	MM6006T	11.73
25A273	.35	25B913	.42	25C986	.62	25C1387	.35	25C98	.45	MM6006U	11.73
25A274	.35	25B914	.42	25C987	.62	25C1388	.35	25C98	.45	MM6006V	11.73
25A275	.35	25B915	.42	25C988	.62	25C1389	.35	25C98	.45	MM6006W	11.73
25A276	.35	25B916	.42	25C989	.62	25C1390	.35	25C98	.45	MM6006X	11.73
25A277	.35	25B917	.42	25C990	.62	25C1391	.35	25C98	.45	MM6006Y	11.73
25A278	.35	25B918	.42	25C991	.62	25C1392	.35	25C98	.45	MM6006Z	11.73
25A279	.35	25B919	.42	25C992	.62	25C1393	.35	25C98	.45	MM6007	11.73
25A280	.35	25B920	.42	25C993	.62	25C1394	.35	25C98	.45	MM6007A	11.73
25A281	.35	25B921	.42	25C994	.62	25C1395	.35	25C98	.45	MM6007B	11.73
25A282	.35	25B922	.42	25C995	.62	25C1396	.35	25C98	.45	MM6007C	11.73
25A283	.35	25B923	.42	25C996	.62	25C1397	.35	25C98	.45	MM6007D	11.73
25A284	.35	25B924	.42	25C997	.62	25C1398	.35	25C98	.45	MM6007E	11.73
25A285	.35	25B925	.42	25C998	.62	25C1399	.35	25C98	.45	MM6007F	11.73
25A286	.35	25B926	.42	25C999	.62	25C1400	.35	25C98	.45	MM6007G	11.73
25A287	.35	25B927	.42	25C1000	.62	25C1401	.35	25C98	.45	MM6007H	11.73
25A288	.35	25B928	.42	25C1001	.62	25C1402	.35	25C98	.45	MM6007I	11.73
25A289	.35	25B929	.42	25C1002	.62	25C1403	.35	25C98	.45	MM6007J	11.73
25A290	.35	25B930	.42	25C1003	.62	25C1404	.35	25C98	.45	MM6007K	11.73
25A291	.35	25B931	.42	25C1004	.62	25C1405	.35	25C98	.45	MM6007L	11.73
25A292	.35	25B932	.42	25C1005	.62	25C1406	.35	25C98	.45	MM6007M	11.73
25A293	.35	25B933	.42	25C1006	.62	25C1407	.35	25C98	.45	MM6007N	11.73
25A294	.35	25B934	.42	25C1007	.62	25C1408	.35	25C98	.45	MM6007O	11.73
25A295	.35	25B935	.42	25C1008	.62	25C1409	.35	25C98	.45	MM6007P	11.73
25A296	.35	25B936	.42	25C1009	.62	25C1410	.35	25C98	.45	MM6007Q	11.73
25A297	.35	25B937	.42	25C1010	.62	25C1411	.35	25C98	.45	MM6007R	11.73
25A298	.35	25B938	.42	25C1011	.62	25C1412	.35	25C98	.45	MM6007S	11.73
25A299	.35	25B939	.42	25C1012	.62	25C1413	.35	25C98	.45	MM6007T	11.73
25A300	.35	25B940	.42	25C1013	.62	25C1414	.35	25C98	.45	MM6007U	11.73
25A301	.35	25B941	.42	25C1014	.62	25C1415	.35	25C98	.45	MM6007V	11.73
25A302	.35	25B942	.42	25C1015	.62	25C1416	.35	25C98	.45	MM6007W	11.73
25A303	.35	25B943	.42	25C1016	.62	25C1417	.35	25C98	.45	MM6007X	11.73
25A304	.35	25B944	.42	25C1017	.62	25C1418	.35	25C98	.45	MM6007Y	11.73
25A305	.35	25B945	.42	25C1018	.62	25C					



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		74C10	.25	7430	.15	74163	1.30	8974	2.95	8553	6.50
4000	.15	74C14	1.75	7432	.30	74164	1.45	8976	2.95	8556	6.50
4001	.20	74C20	.26	7437	.44	74165	1.35	75107	3.25	8599	3.25
4002	.20	74C30	.26	7440	.18	74166	1.20	75450	1.00		
4007	.20	74C32	.30	7442	1.00	74173	1.70	75451	.80		
4010	.36	74C42	1.40	7445	.70	74175	1.05	75452	.80		
4011	.20	74C48	2.75	7446	.70	74177	.90	75453	.80		
4012	.20	74C73	1.25	7448	.70	74182	.95	75491	1.25		
4013	.35	74C74	.75	7450	.25	74191	1.20	75492	1.40		
4014	.85	74C86	1.00	7451	.25	74192	1.45	75494	1.50		
4015	.30	74C90	1.10	7453	.25	74193	1.35				
4016	.35	74C93	1.25	7454	.35	74195	1.00				
4017	.92	74C151	2.75	7460	.22	74196	1.10	8212	3.50	301N	1.00
4018	.92	74C154	3.00	7472	.40	74197	1.10	8214	8.50	307N	.30
4019	.20	74C157	2.10	7473	.40	74199	2.25	8216	3.75	308H	1.00
4020	1.00	74C160	1.40	7474	.40	74367	.90	8224	4.75	309K	1.20
4022	.83	74C162	1.70	7475	.55			8228	9.90	309H	1.00
4023	.21	74C164	1.75	7476	.45			8251	11.50	318H	1.50
4024	.75	74C165	1.75	7483	1.05	0025	3.50	8255	10.50	320H-5	1.25
4025	.20	74C174	1.50	7485	1.10	0026	1.75	2513	9.50	320T-5	1.25
4027	.34	74C902	.85	7486	.43	8540	1.25	2516	9.50	320T-12	1.25
4028	.79	74C904	.85	7489	2.00	8541	2.75	1013	6.50	320T-24	1.25
4029	1.00	74C905	3.00	7492	.75	8806	3.00			387N	1.25
4030	.20	74C914	1.95	7493	.65	8819	1.25	8000		388N	1.15
4035	.95			7495	.78	8820	5.00	8720	3.25	555N	.80
4040	1.00			7496	.85	8830	4.90	8737	1.75	556N	2.00
4041	1.00	7400	.16	74121	.35	8833	2.45	8092	.95	561N	6.00
4042	.70	7401	.17	74122	.45	8835	2.45	8094	.60	566N	1.60
4044	.60	7403	.17	74123	.65	8836	1.25	8095	.80	567N	1.05
4049	.35	7404	.19	74126	.65	8837	2.45	8096	.90	709N	.30
4051	1.10	7406	.40	74132	1.25	8838	2.45	8098	.90	741H	.25
4066	.70	7407	.40	74141	1.15	8859	1.50	8121	2.25	9030S	2.40
4068	.40	7409	.25	74145	1.10	8865	1.50	8136	3.25	3401	1.25
4069	.40	7410	.18	74148	1.20	8866	1.50	8220	3.25		
4075	.20	7413	.78	74150	.90	8867	1.85	8231	2.25	74LSxx *	
4082	.23	7414	.68	74153	1.10	8869	1.75	8242	1.75	74LS50	.25
74C00	.25	7415	.36	74154	1.25	8879	2.25	8250	1.75		
74C02	.45	7420	.18	74155	.75	8880	2.75	8260	2.25		
74C04	.32	7421	.36	74157	1.00	8884	2.45	8281	1.00	74LS670	3.95

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AN324	8.85
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AN329	7.70
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AN334	9.90
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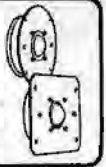
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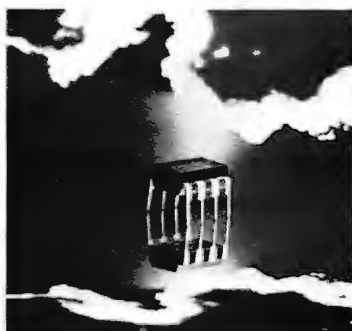
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# ELECTRONICS WORLD<sup>®</sup>

## *News Highlights in Brief*

### Computer Aids Disc Mastering

According to CBS Records, its New DISComputer<sup>™</sup> record mastering system promises louder, longer-playing records. The device uses a computer to pre-read tape being mastered 0.167 second before the cutter, and to signal the lathe to adjust the excursion of the cutting stylus to accommodate as much audible sound as possible. By allowing the lathe to anticipate signals to come, it is said to add up to 5 minutes of music per side to LP's and to increase recorded levels by as much as 2 to 5 dB. The computer, which is programmed for use with Scully or Neumann lathes, also uses its memory to compare the preview-head signal to previously cut grooves. This allows DISComputer<sup>™</sup> to take into account such subtleties as the average level on the disc, and to prevent groove echo by "remembering" never to closely space loud and quiet grooves. A company spokesman says 10 percent of all CBS Records produced in 1978 were mastered using the \$250,000 DISComputer<sup>™</sup>.

### Talking Clock

The TCE-124 "Talking Clock" from Omnicron Electronics, Putnam, CT, automatically delivers 12- or 24-hour time announcements in "a distinctive male voice," in English, German, or Arabic. Designed to be used with voice- or device-activated recorders, the TCE-124 automatically inserts its announcements on the tape at the completion of each message or data recording. The voice is generated by solid-state electronics, and there are no tapes or discs to wear. Other features of the clock include a LED display and monitor speaker, MSI/LSI circuitry, one watt, 8-ohm audio output and compact size.

### Pendant Saves Lives

Microlet Systems, Burbank, CA, has developed a new wireless communicating device for emergency medical attention called "Microlet." The matchbook-size, dual-contact pendant is actually a 1-ounce transmitter. It will signal its receiver (located up to 300 ft away) to make telephone calls, giving the type and location of the emergency. When the dual-contacts are squeezed, a radio signal sets off the alarm. The system can make five or more preprogrammed, pretaped telephone calls. Although "Microlet" was developed for medical emergency purposes, it is suitable for use in a home or business to signal a robbery or any other emergency.

### Acupuncture with Laser Beam

Acupuncture (a fairly ancient art) and lasers (rather new) are combined in the new "akupLas" therapy unit from Germany's Messerschmitt-Bolkow-Blohm. The helium-neon laser's beam has a wavelength of 632 nm, to which the skin is fairly transparent. This allows the 1-mm diameter, 2-mW beam to penetrate to a depth of 3 to 10 mm, depending on the type of skin. A fiber-optic tube guides the beam from the laser to the therapist's hand-piece, which can be placed directly to the skin.

### VTR Interference Problems

If you have recently bought a video tape recorder and are using it with a TV receiver that is more than, say, a year old, you may be having VTR interference problems. This is generally experienced as a 1-inch to 1½-inch, 45° bending at the top of the screen. While television manufacturers say that modifications have been made to the design of their receivers in recent months to avoid such interference, some are being compelled to modify older sets to accommodate a VTR. It has been explained that the difficulty stems from anti-flutter circuits built into older TV receivers to filter the maximum amount of external interference. As a result, the circuits do not lock on to the TV signal quickly. With a VTR, however, immediate locking in of the signal is required. Some compromise in the anti-flutter circuitry is thus required for video tape machines.

### ASCII for Ham RTTY

In a move to allow Ham radio operators to operate more sophisticated amateur communications rigs, the FCC has proposed to allow them to use ASCII code for radio teletype transmissions. In the past, only Morse and five-unit Baudot codes have been permitted in amateur radio operation. The move would allow Hams to use a variety of computer terminals for transmissions.

### More Efficient Solar Cell

A prototype solar cell which converts a record 28.5% of sunlight to electricity has been developed by Varian Associates, Inc., under a Department of Energy contract administered by Sandia Laboratories. The highest efficiency previously reported was 23% for an AlGaAs cell. The new system uses two different solar cells—an AlGaAs cell and a silicon one—to absorb a wider range of solar wavelengths. A special filter reflects low-energy, long-wavelength rays to the silicon cell while permitting higher-energy, shorter-wavelength rays to pass through to the AlGaAs cell. In the prototype, various optical losses reduce the overall system efficiency to about 25%, but it is hoped that this can be raised to 30% by stacking the cells and eliminating the filter.

### Computer Chess in Canada

The classic struggle between man and machine was continued over the chess board at the 100th anniversary of the Canadian National Exhibition in Toronto last September. The occasion was the UNCOMMAN (UNiversal COMputer MAN) Chess Event, sponsored by WINTARIO and Control Data Corp., under the auspices of the Ontario Chess Association. The public was able to try its skill against Commodore's Pet personal computers, programmed to play chess at eight different levels of expertise. During the event, a match was played between International Master David Levy and CHESS 4.7, a computer program developed by David Slate and Peter Atkins of Northwestern U. The program was run on Control Data's CYBER 176, in Minneapolis, and connected by phone lines to a terminal in Toronto.



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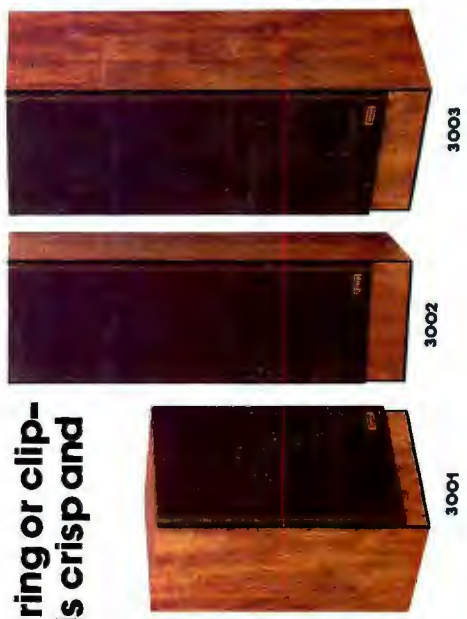


# The Pile Driver: It's just no match for the Heil Driver.

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The revolutionary new Heil Driver in Lafayette's Criterion Series 3000 loudspeakers "shoots" the sound out.

There's no blurring or clipping. Every note is crisp and clearly defined.



Ever since "talking machines" first started talking, speakers have produced sound by pushing the sound waves out of the speaker with a diaphragm. Sometimes referred to as a "driver." Or "pile driver."

This system has definite disadvantages. To reproduce sound faithfully, the driver has to have very rapid rise time (acceleration) and decay time (deceleration). But the mass of the driver is so great, it fights against its own immense inertia. So sound gets blurred. Parts of notes get clipped short.

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